THE ENGINEER.

# Auxiliary Machinery on Merchant Steamers.

## AUXILIARY MACHINERY ON MERCHANT STEAMERS.

SECTION I.—INTRODUCTION.

AUXILIARY machinery on board modern merchant steamers even of the ordinary type, but still more so in the case of particular ships for special kinds of service, has undergone considerable change within recent years. The development of electricity on board ship for power purposes, as well as for lighting; the adoption of the turbine principle of propulsion for cross-Channel and ocean-going passenger steamers; the increase in the number and the size of dead meat carrying steamers; and the radical modifications in the general design and equipment of ships engaged in bulk cargo carrying, with a view to extreme despatch in loading and discharging—all these are matters which have had distinct influence of late in modifying conventional and standard facilities and practice in respect of steamship auxiliary machinery.

One general and highly important question which has been long debated and tentatively experimented with—and in some cases definitely solved—is the question as to whether the pumping arrangements in merchant steamers—of the mail and passenger class as well as the purely cargo-carrying order, but more particularly the latter—should consist of the time-honoured but dependent association with the main engines, or should be separate and independent. The supporters of the latter view, indeed, advocate each item being self-supporting and sufficient in such circumstances as a main breakdown, &c., or the various items being grouped and associated as far as possible to take their motive power from a common source, not associated, however, with the main propelling engines. Sea-going and superintendent engineers for a variety of reasons—not always essentially a part of pure engineering—are still debating it. While reliability in working and economy of upkeep have been all along recognised as necessary requirements — in mail and passenger steamers as in the more humble cargo carrier — the question of running economy has been the crux of the question as regards the latter class of vessel. In the case of mail and passenger steamers, where speed and regularity are paramount considerations, coal and steam consumption are comparatively minor considerations, and for many years independent working pumps have been employed. The *pros* and *cons* of the question as regards slow-going and economically worked cargo vessels, however, are still and may yet for many years be discussed, and experimented upon, with varying results and impressions.

The era of independent auxiliaries for steamships of the regular mail liners—such a stage, no doubt, has now been reached—has been to a large extent furthered by the extended application of electricity on board ship, for power purposes as well as for lighting, and by the higher pressure of steam which the main propelling engines can now more efficiently utilise. Still more, in the case of the most recent vessels fitted with steam turbines for propulsion instead of the conventional reciprocating engines, there is little, if any, foothold or standing for pumps and other auxiliary items being associated with the main engines. Not only has the adoption of the turbine principle for ship propulsion brought about modifications in the arrangement and working of the usual auxiliary machinery in engine-rooms, but it has to some extent influenced the adoption of items new and special.

At this point the modifications of most note thus brought about may in a general way be outlined. With the firmly established advent of the turbine came, first, the demand for an independently-driven air pump, because the pumps driven from the turbine shaft had been found unsatisfactory and inadmissible for marine work; and, secondly, for an arrangement of air pump which would give a high percentage of vacuum, and enable the full economy of the turbine system to be realised. As regards condensing plant, the advent of the turbine made it imperative that this should be independent, and as efficient as possible under all conditions of working. In large sea-going vessels in the best practice there is a separate auxiliary condenser by which the necessity is avoided of connecting the auxiliary exhausts to the main condenser, and also running the risk of causing air leakage. Besides making the adoption of "independent" air-pumps advisable, if not absolutely necessary, the great need for securing and maintaining high vacuum in order to obtain the greatest efficiency with the turbine has brought about the adoption of special devices for assisting the ordinary air pump in effecting this object. Regarding the subject of vacuum, the Hon. C. A. Parsons

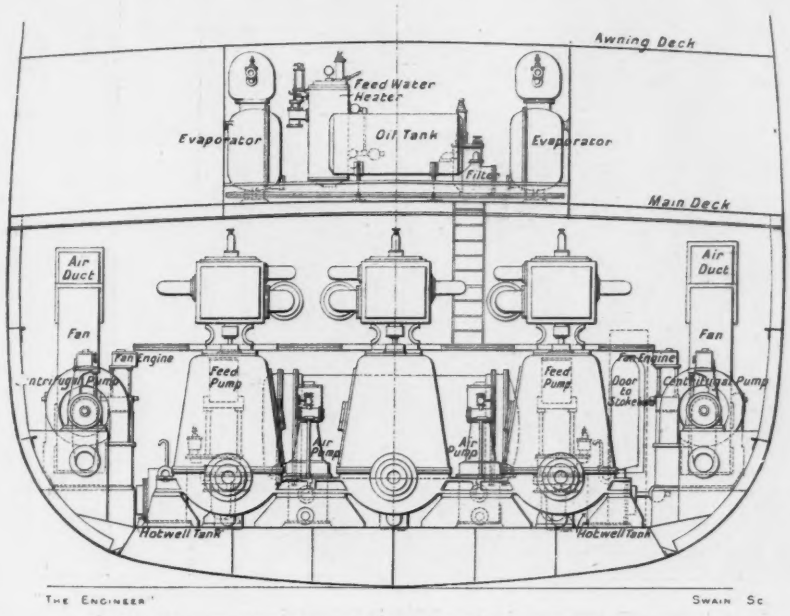


Fig. 1—MAIN AND AUXILIARY MACHINERY FOR TRIPLE-SCREW STEAMSHIP

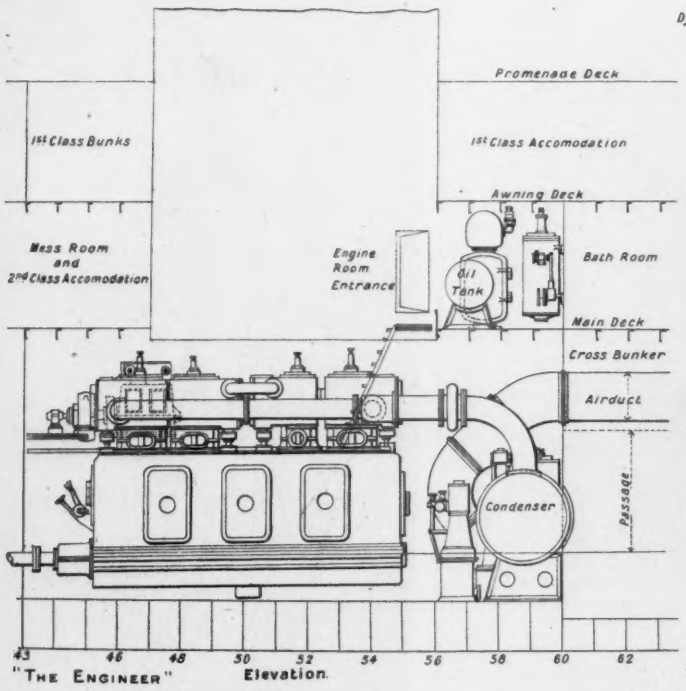


Fig. 2—LONGITUDINAL ELEVATION OF MACHINERY

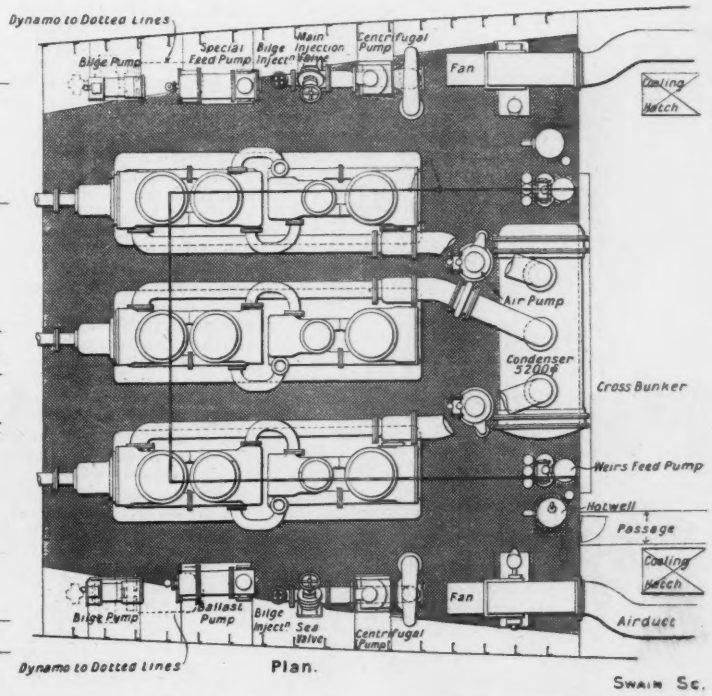


Fig. 3—PLAN OF MAIN AND AUXILIARY MACHINERY

has said:—"An addition of 1in. to the vacuum in the condenser over 26in. deducted 4 per cent. from the steam used, a further increase of the same amount 1in. meant a further gain of 4½ per cent., while 29in. brought the steam consumption down 5½ per cent. more." The "vacuum augmenter," designed by the Parsons Company, has been applied to increase the vacuum above that obtained by the air pump. This briefly, as is well known, consists of a smaller auxiliary condenser placed below the main condenser and connected to it by a pipe having a conical contracted portion through which a jet of steam is forced. The effect of this is to exhaust most of the air and vapour from the condenser and deliver it to the air pump. By arranging the air pump suction pipe with a dip the air and vapour is prevented from returning to the condenser by the water contained in the pipe, thus forming what may be termed a "water seal." The "vacuum augmenter" has been found in some cases to increase the vacuum by about 2in. above that obtained with the ordinary air pump.

Some time ago the firm of G. and J. Weir, Cathcart, began to manufacture the Weir dry air pump, as a supplementary or intensifying auxiliary to its make of "wet" air pump. The purpose of this pump is really to take care of leakage in excess of the normal, and it provides an auxiliary of large capacity and comparatively light weight through being capable of running at a high speed. It has been fitted in one form or another in many of the recent turbine vessels. In some of the earlier plants the dry air pump was driven by the centrifugal pump engine, but in later practice it has been disassociated from that engine and driven by a separate high-speed engine.

The practice of some firms, however, having large experience with turbine vessels, still is to fit wet-air pumps only, these being driven from the same engine as the circulating pump, and the combination, it is claimed in at least one case, proves quite efficient.

The introduction of turbine engines has brought about little or no change in the feed pump plants on board ship, but in the matter of heating the feed-water the adoption of turbine machinery necessitates some important modifications. Owing to the high vacuum the natural temperature of the feed-water is low, and feed heating is thereby rendered a matter of extra importance. There being nothing corresponding to the intermediate receiver in turbine machinery from which the steam may be taken, practically the only steam available for heating purposes is that from the exhaust of the auxiliaries. Further, formerly the main engines had attached to them the hot-well pumps for discharging the feed-water from the hot well up to the direct contact feed heater, while now there are no pumps worked from the turbine shaft. For these and other considerations the feed heater in turbine vessels—unless on the very largest sizes—is generally of the surface type, fitted between the feed pump and the boiler. In one other direction the introduction of turbine propulsion has brought about almost an entirely new auxiliary item, namely, oil pumps for circulating oil throughout the bearings. To this and the other items already noticed in general terms more detailed reference will be made and illustrations given further on

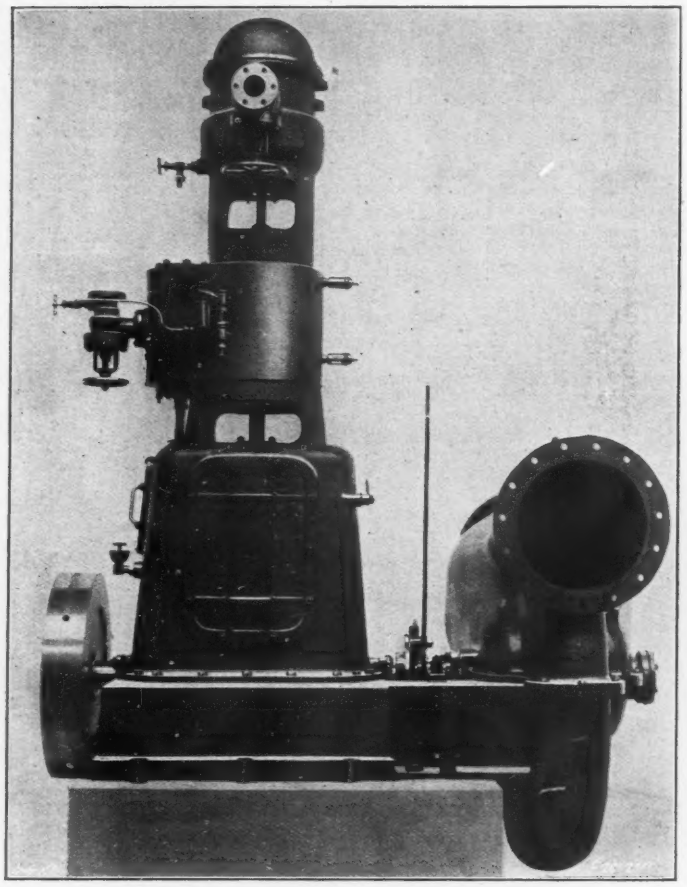

Fig. 4—A DRY AIR AND CIRCULATING PUMP PLANT—WEIR

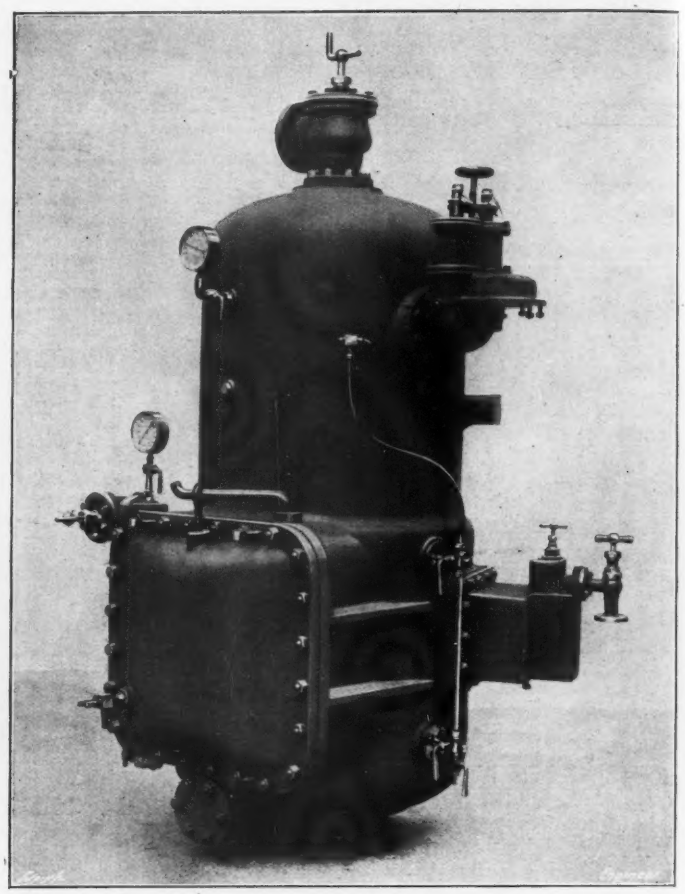

Fig. 5—VERTICAL EVAPORATOR FITTED TO S.S. BOGOTA—WEIR

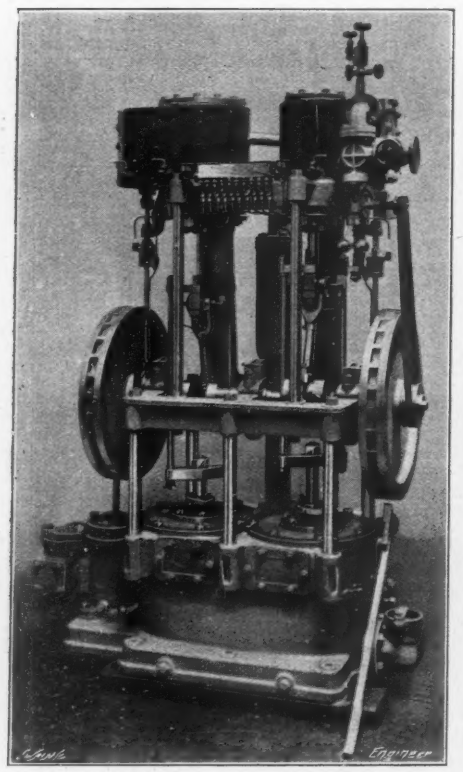

Fig. 6—VERTICAL VACUUM PUMP—CARRUTHERS

## SECTION II.—ENGINE AND BOILER-ROOM AUXILIARIES.

It goes without saying that independent condensers, pumps, &c., involve a relatively higher initial—and possibly a heavier running—cost than pertains to the auxiliaries under the conventional arrangement. This undoubtedly is in itself a deterrent factor in the development of the independent principle in steamship engine-room outfit. But in this connection special or exceptional cases are occurring to prove the validity of the conventional rule. The variety and arrangement of the auxiliary items in a turbine engine-room are matters which perhaps have already received sufficient illustration in engineering and shipping journals. Figs. 1, 2, and 3 illustrate the arrangement and equipment of the engine-room of a steamer which, while not a "turbiner" is yet representative of the progressive spirit with which engineers, shipbuilders, and shipowners are now meeting and helping forward the trend of development.

The illustrations represent the engineering "vitals" of a triple screw-propelled vessel for South America to be built by Gourlay Brothers and Co., Dundee, similar to the Londres, built for service in that country last year. The Londres is a vessel specially designed for passenger and goods river traffic on the River Plate. Hitherto all the steamers belonging to the same owners have been of the paddle type, owing to the shallow draught in the upper reaches of the river. It was desired, however, to get screw-propelled boats if the requisite light draught could be guaranteed. At first turbines were thought of, but eventually reciprocating engines were designed. These engines, as will be seen from Figs. 1, 2, and 3, comprise

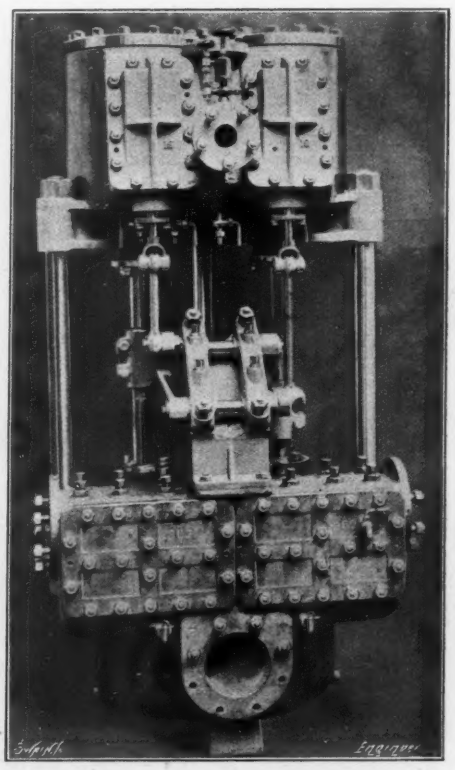

Fig. 7—GENERAL SERVICE PUMP—CARRUTHERS

# LATEST TYPES OF WEIR'S PUMPING MACHINERY

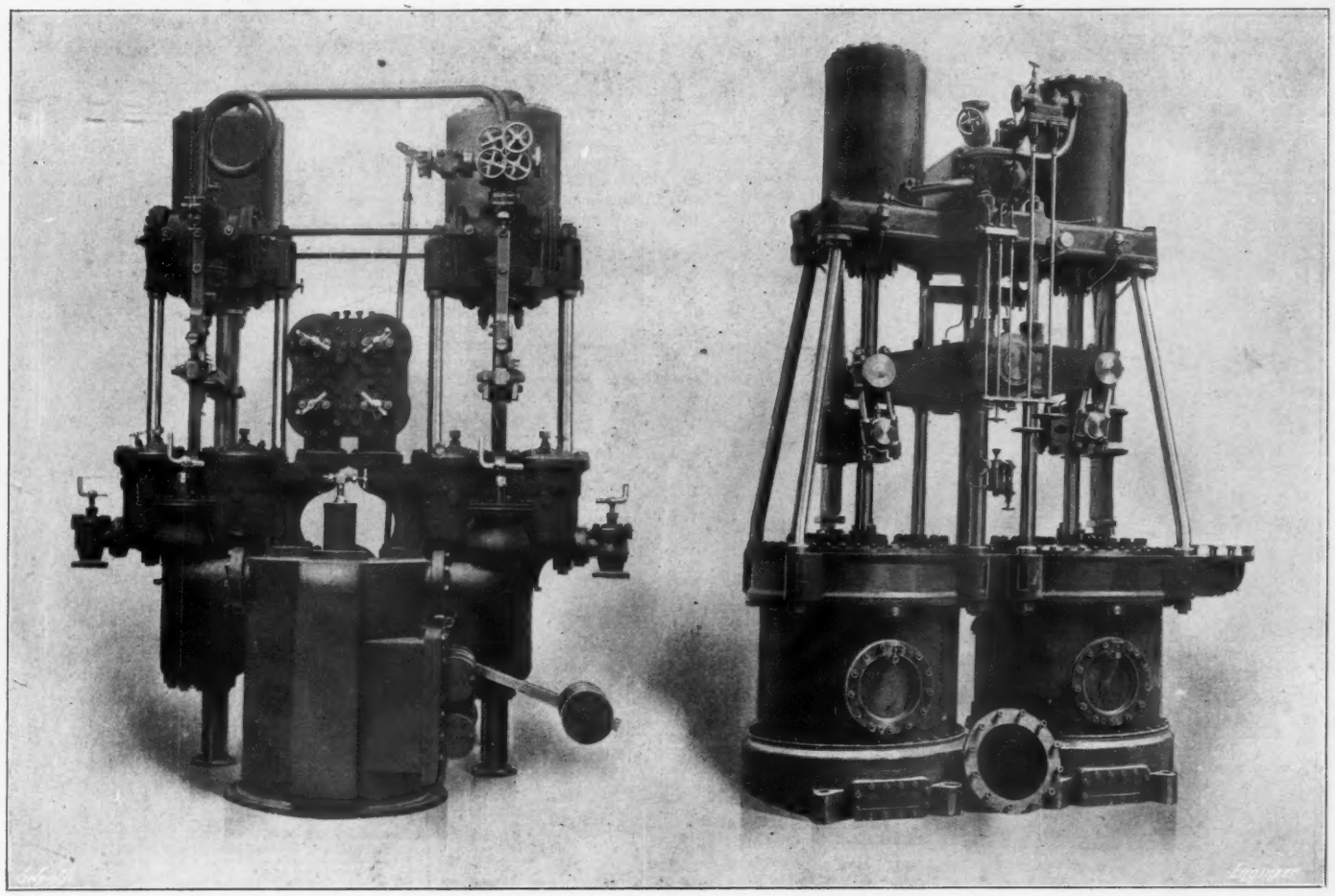

Fig. 8—DIRECT-ACTING FEED PUMPS FOR T.S. VIKING

Fig. 9—TWIN TYPE OF INDEPENDENT AIR PUMPS

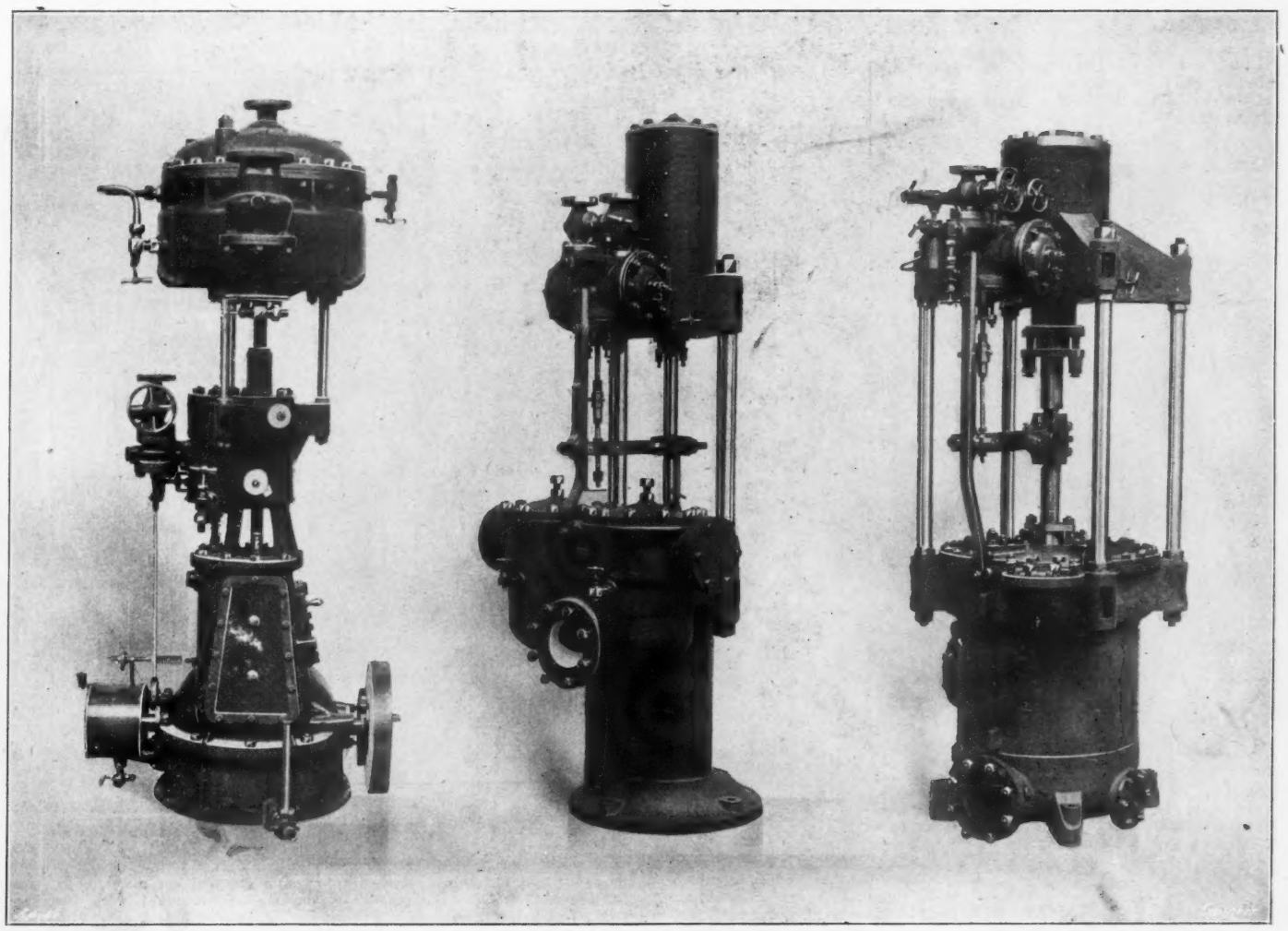

Fig. 10—DRY AIR PUMP

Fig. 11—GENERAL SERVICE PUMP

Fig. 12—MONOTYPE AIR PUMP

three sets, each having four cylinders working on four cranks, and driving three propellers. To ensure running without vibration was an essential feature, and these engines on trial ran noiselessly at a speed of about 250 revolutions per minute. The working parts are all carefully balanced, and their lubrication is done mechanically under pressure, the effect being that the whole of the working parts are practically floating in oil, so that all knocking and vibration are done away with. The oil pumps adopted for this purpose are of Weir's design and manufacture. All the air circulating, feed and bilge pumps are worked by independent engines of the latest types.

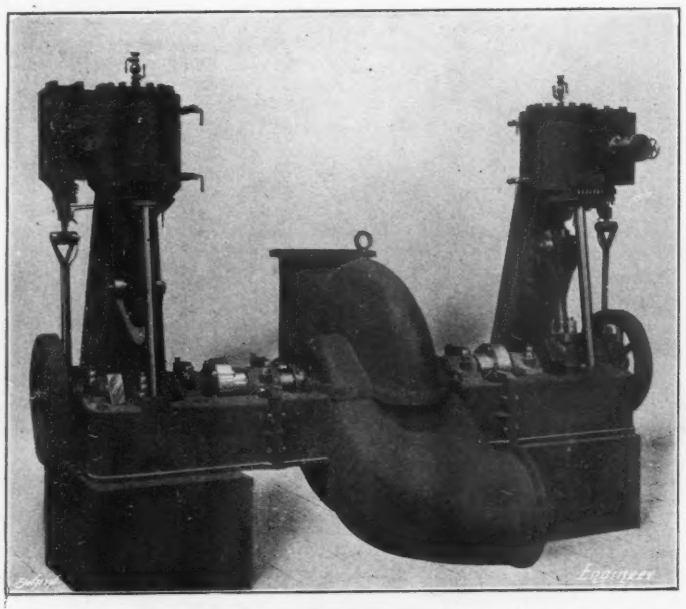

Fig. 13—STEAM DRIVEN CIRCULATING PUMP FITTED ON CARMANIA—ALLEN

The boilers are four in number, are made for a working pressure of 180 lb. per square inch, and are fitted with forced draught supplied by two large fans. The Londres attained a speed of nearly 18 knots with a draught of only 7ft. Another feature of this steamer is the driving of all the deck machinery by hydraulic power, thus ensuring both rapid and noiseless working; the main features of which are dealt with later on in this article.

The marine auxiliary plant in the way of pumps, evaporators, &c., which the firm of G. and J. Weir, Limited, Cathcart, has been so long noted for, scarcely calls at this late date for any extended description, but modifications due to the introduction of the turbine principle have had to be made, and a number of illustrations of the specialities of this firm, together with some brief notes, may be of interest. Fig. 8, page 3, shows a

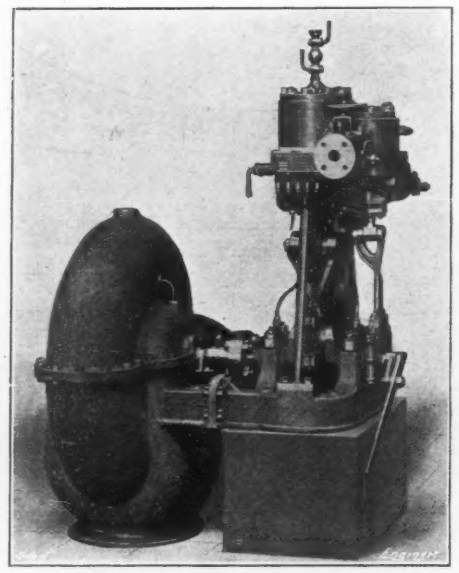

Fig. 14 CIRCULATING PUMP—ALLEN

pair of Weir direct-acting feed pumps 13in. diameter by 26in. stroke, with float tank and automatic control gear as fitted on the turbine steamer Viking. These pumps have gun-metal water ends, gun-metal buckets and manganese bronze rods, and are of the firm's latest and most approved type. Each pump is capable of delivering feed-water for the total horse-power—10,000 indicated horse-power. Fig. 9 illustrates a pair of Weir independent air pumps—twin type—as fitted on the turbine Cunard liner Carmania and other Atlantic liners. They are of the standard Weir type, with one single steam valve for both cylinders, situated compactly between the two steam cylinders. The barrels are of gun-metal, with bronze pump rods, and the pumps are fitted with foot, bucket, and head valves. Special attention may be directed to the merits of the design as regards manipulation of valves, large bearings, &c.

An example of the Weir dry air pump driven by a Weir enclosed engine, to which reference was made above, is illustrated in Fig. 10. The air pump is supported on columns from the steam cylinder, and is of the single-acting type, fitted with cooling arrangements. The air pump barrel is of gun-metal, fitted with a gun-metal bucket and valves specially designed for the particular duty. The general design is light, simple, and the performance of the apparatus is said to be satisfactory. Fig. 11 shows a Weir general service pump 11in. diameter by 21in. stroke, and is an example of a type of pump which has been largely developed by the firm of late for ballast and general purposes on board ship. The pump is of cast iron, fitted with a gun-metal liner, gun-metal bucket, bronze rod, and large valve area, with disc type valves. It meets the demand for a somewhat better class auxiliary in this department, and is generally of better design and more substantially built than the ordinary make of pump so largely used. Fig. 12 shows the Cathcart firm's latest novelty in air pumps, viz., the Weir monotype air pump. This example is 24in. diameter by 18in. stroke. The monotype pump is of the direct-acting variety, and is the result of a number of years' experimenting with the object of securing a direct-acting air pump, economical in steam and uniform in stroke under all conditions of duty. It forms one of the most compact and efficient latter-day marine auxiliaries, and is being largely adopted in all classes of vessels, both singly and in conjunction with the dry air pump on turbine vessels.

Messrs. Weir have devised a special form of combined feed heater and auxiliary condenser of the surface type. It is divided into two portions, the primary being the feed heating portion, and the secondary the condensing portion. The main feed-water supply is discharged through the tubes of the first portion by the air pump, being heated in its passage by the exhaust steam from the auxiliary machinery, which, under normal conditions, is all condensed by the feed-heater. The two portions of the apparatus are in communication on the steam side, so that if for any reason the feed heater is insufficient to condense all the steam, the uncondensed portion passes over into secondary half of the apparatus, through which the circulating water passes, this being taken from the sea or other convenient source. An excellent feature of this arrangement is that it enables the feed-water derived from the auxiliary exhaust steam to be filtered separately before being mixed with the main feed-water.

A dry air pump and circulating pump engine of the Weir enclosed type 10½in. diameter by 9in. stroke, driving a 16in. air pump and a centrifugal circulating pump, is shown in Fig. 4. The illustration is from a photograph of the engine fitted on the cross-Channel turbine steamer Princess Elizabeth. It has, it is said, proved successful, but in later practice the dry air pump is dissociated from the centrifugal pump unit, and is driven by a separate engine. The plant shown is a neat and compact arrangement, and is given as an example of actual practice.

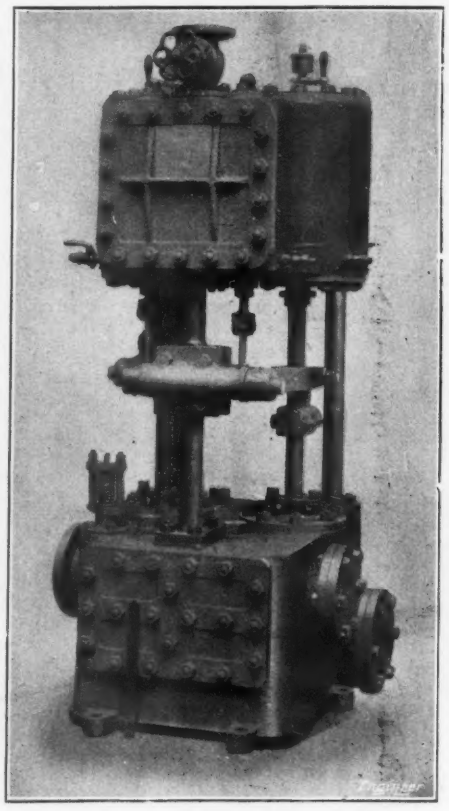

Fig. 15—FEED PUMP—CARRICK AND WARDALE

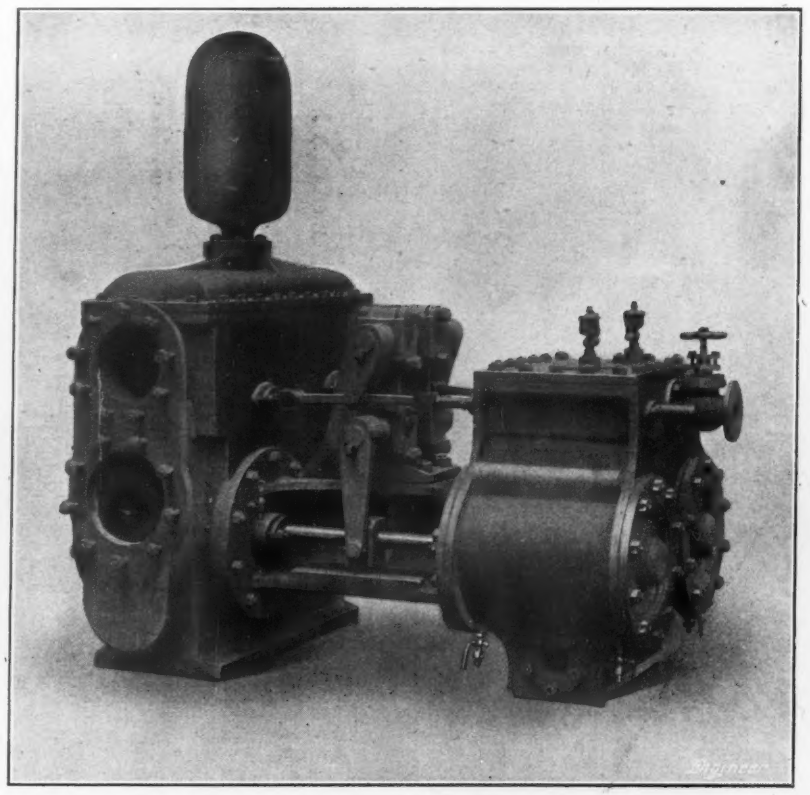

Fig 16—HORIZONTAL DUPLEX SLIDE VALVE BALLAST PUMP—CARRICK AND WARDALE

Considerable misconception appears to exist as to the necessity for, and function of, the dry air pump, on account of the necessary vacuum being obtainable in some cases by means of the wet air pump only. It should be borne in mind that even a slight fall in vacuum affects the efficiency of the turbine to a considerable extent, so that special provision for maintaining the vacuum under all conditions of leakage is both necessary and justified. So long as the system is reasonably

free from leakage, the wet air pumps are generally of such a size as to secure a good vacuum, but should any unexpected or abnormal leakage take place, the dry air pump can be put on to maintain such conditions of vacuum as will enable the normal efficiency of the turbine to be secured and the vessel's speed to be main-

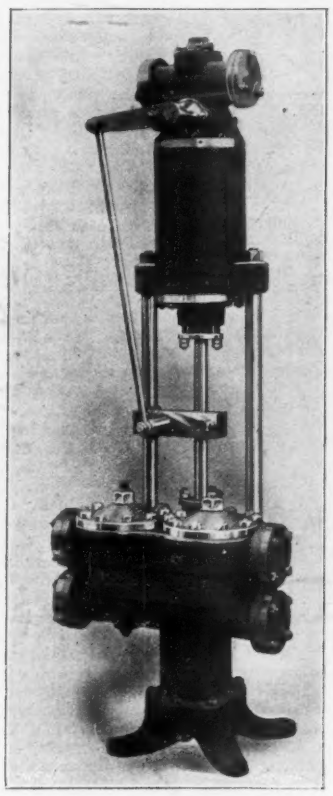

Fig. 17—VERTICAL FEED PUMP—BAILEY

tained. Naturally, the sizes and proportions for the various units of these plants are the result of experience, and from the increasing range of plants at work it may be concluded that the makers will introduce modifications and improvements as a result of their observations of those at present at work.

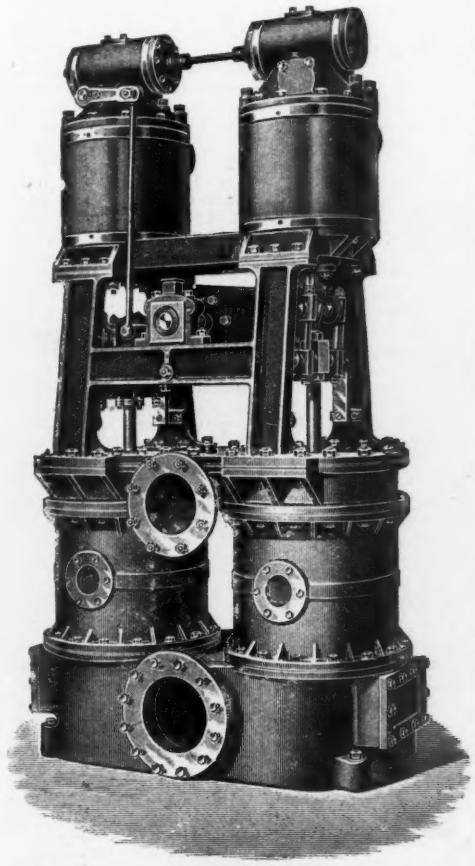

Fig. 18—VERTICAL TWIN-CYLINDER AIR PUMP—BAILEY

Air and circulating pumps of the crank type are well-known productions of J. H. Carruthers and Co., Polmadie, Glasgow. One of the recent plants erected by this firm which has amply justified itself is that put on board the turbine Cunard liner Carmania, consisting of two vertical duplex ballast pumps, 12in. stroke, each capable of discharging 400 tons of water per hour; two bilge pumps of the same type, 8in. and 9in. diameter by 8in. stroke; two sanitary pumps 8in. and 8in. diameter by 8in. stroke; and two fresh water pumps 5¼in. and 5in. by 5in. stroke. The use of the crank in this case has, it is claimed, the advantage over the direct-acting type in that it permits of the use of Edwards' type of pump, and also allows of working with very small clearances. Fig. 6 illustrates a compound vertical crank drum vacuum pump specially designed for use with an independent condensing plant where a high vacuum is desired. The design shown has been arranged for long-continued working without attention. Fig. 7 illustrates a modern general service and feed pump of the vertical duplex type by the same firm, designed for steam and water pressures up to 250 lb. per square inch. The water valves are arranged in groups, and care has evidently been taken to provide ample strength in all parts, and give ready access wherever it may be needed.

Of one of the steam-driven circulating pumps for which, along with other items of auxiliary plants on board ship both for the merchant service and the leading navies, W. H. Allen, Son and Co., Limited, Bedford, have long been noted makers, we present an example in Fig. 13, page iv. This shows a steam-driven main circulating pump, as fitted on board the Cunard liner Carmania. The two engines, it will be seen, are placed on each side of the pump, which has suction and discharge branches 26in. in diameter. The disc is 4ft. 6in. diameter, and is of gun-metal throughout. It has a bronze spindle. The engines, which have cylinders 14in. diameter by 12in. stroke, are of a simple, neat, and open design throughout, the material, of course, being of the highest quality. The cylinder and piston valve in each case are one casting of high-grade cast iron mounted upon a column and bed-plate of the same material, which are of substantial box section. The parts of the engine, it will be noted, are easily accessible, there being only a light steel column in front to add extra rigidity. Fig. 14 shows a neat type of steam-driven circulating pump of the same firm's manufacture. It is of specially light design. The pump disc is of gun-metal throughout, with a bronze spindle, while the engine trunk and base plate are cast in bronze, and of very light section.

The latest type of horizontal duplex ballast pump made by Messrs. Carrick and Wardale, of Redheugh Engine Works, Gateshead-on-Tyne, is illustrated in Fig. 16. Such pumps have been supplied to the Admiralty and the leading ship building firms of this country. They are made in various sizes for capacities from 35 to 350 tons of water an hour. Instead of being fitted with ordinary lift or mitre valves, the water is pumped automatically by means of a D slide valve; this arrangement allows the valve to open with the movement of the plunger, and is not dependent upon the vacuum to lift the valves. There are only two valves, one for each pump, which answer for the suction and delivery, and they can be arranged for working either horizontally or vertically.

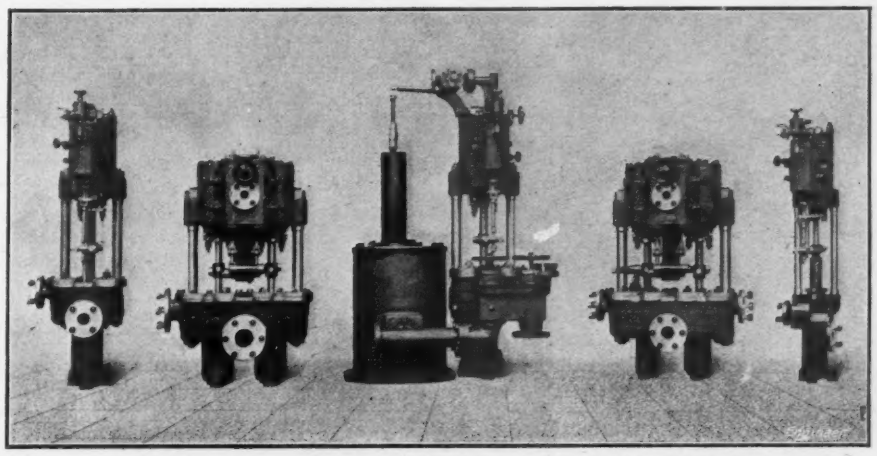

Fig. 19—SET OF PUMPS FOR AN INDIAN SURVEY VESSEL—HALL

The pump or piston-rod lever of one cylinder works the water valve automatically on the opposite side and *vice versâ*. All the pumps are lined with gun-metal and have a false face fitted for each water valve, which can be renewed. The levers are all of mild steel shrunk and keyed on to their respective gudgeons, and the brackets for the same are fitted with keeps, which allow these levers to be taken out without having to remove the whole bracket. The pump piston-rod, to which is bolted a steel crosshead, is guided to prevent the rods from turning and bending the lever. The suction and delivery branches are arranged on either side of the pump, and by taking off the flange from one side, or by removing the cover, the working valves, of which there are only two, can be immediately got at. The waterways are all of large area, to allow of a low velocity of flow into the pump barrels.

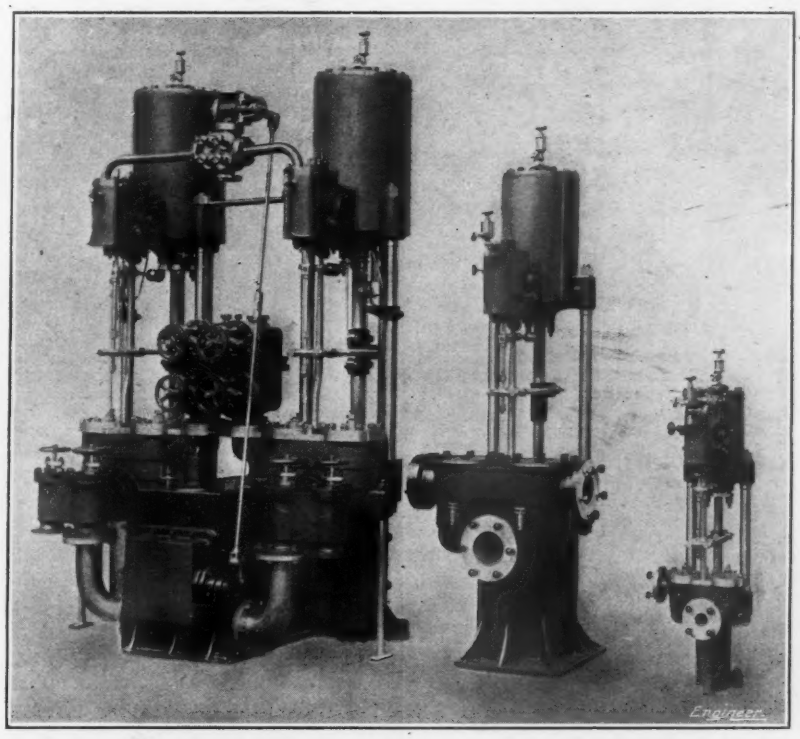

Fig. 20—MAIN FEED, BALLAST, AND SANITARY PUMPS FOR A LARGE VESSEL—HALL

Messrs. Carrick and Wardale have for many years made a speciality of pumping ship's ballast with a slide valve instead of the ordinary lift or mitre valve, and the advantage they claim for this type of valves is that they are less liable to choke than ordinary valves, and will pump semi-fluids, hot water, or water heavily charged with grain, chips, waste and ashes, as are invariably to be dealt with after ballast tanks have been used for cargo. In fact

any obstruction, it is said, will pass through the ports or valves. Another advantage is that they always give a full bore discharge and are noiseless. They are well

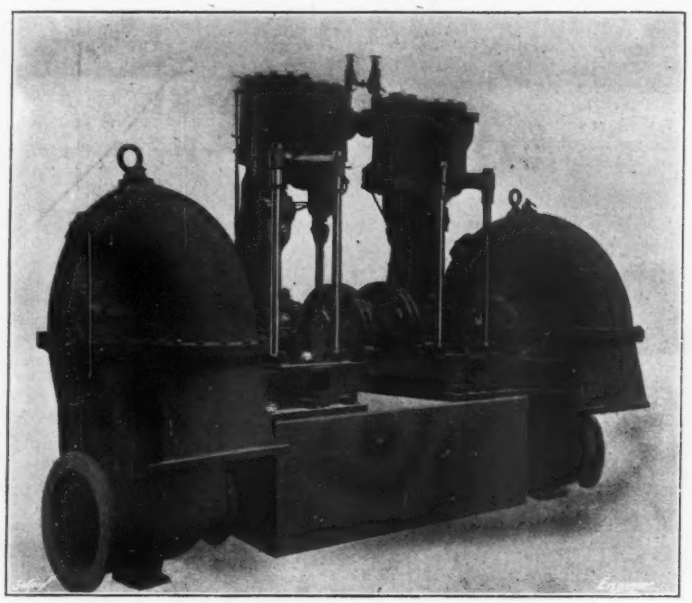

Fig. 21—CIRCULATING PUMPS FOR S.S. HELIOPOLIS—DRYSDALE

built, and for their respective capacities take up little space.

The engraving, Fig. 15, illustrates Carrick and Wardale's standard type of vertical duplex boiler feed pump arranged for boiler pressures of 250 lb. per square inch, and in a variety of sizes for capacities of from 1500 to 10,000 gallons of water per hour. The pump ends are usually made all in gun-metal, but can be designed with cast iron water ends, gun-metal fitted. The suction and delivery branches are arranged on both sides of the pump. The pumps are each double acting, fitted with eight valves in all, of large area and small lift, and the water passages are arranged for an easy flow at a low velocity. The valve seats are held in position with a brass spindle screwed from the top of the pump, and, by removing the doors and unscrewing the cap, all the valves can be got at for repairs or examination. The pump cylinders are supported by means of three heavy turned steel pillars, the centre one of which is arranged for carrying the brackets for actuating the valve gear. The pumps are substantially built and suitable for the heavy work for which they are intended, and provided with a hand lever for filling the boilers when steam is not available.

The engravings given in Figs. 17 and 18 illustrate two pumps made by W. H. Bailey and Co., Limited, of Albion Works, Salford, which are admirably suited for marine purposes. Fig. 17 represents a Davidson vertical boiler feed pump, which, owing to its high efficiency and small space occupied, is largely used in marine work. The special feature is the valve gear, which is actuated by a positive mechanical connection with the main piston-rod of the pump, being assisted in its movements by steam. It has a positive and mechanical closure of the steam port before the piston reaches the end of its stroke, thus using the steam expansively, slowing down the speed and, preventing wear and tear of valves. These pumps use very little steam. There are not many working parts, a fact which will be appreciated when we state that there are only two stuffing-boxes, two pistons, and one slide valve. The pump water cylinders are lined with gun-metal, and the valves are of the same material. The pump rods are made of bronze. The pumps are sufficiently strong to stand steam and water pressures up to 150 lb. per square inch.

One of the latest types of air pumps is illustrated in Fig. 18. It shows a Davidson vertical twin-cylinder air pump, also manufactured by W. H. Bailey and Co., Limited, which is largely used for marine work. It has two steam cylinders which are supported by a cast iron H frame. This also carries the main beam, bearing, and guides for the crossheads. The valve gear in this case also is of the Davidson design. By means of valve rods it controls a plain slide valve in the opposite chest, and it is interesting to note that the steam chests are placed horizontally on the cylinders. The top valve plates and heads can easily be removed, and the valves in the channels and buckets are readily accessible.

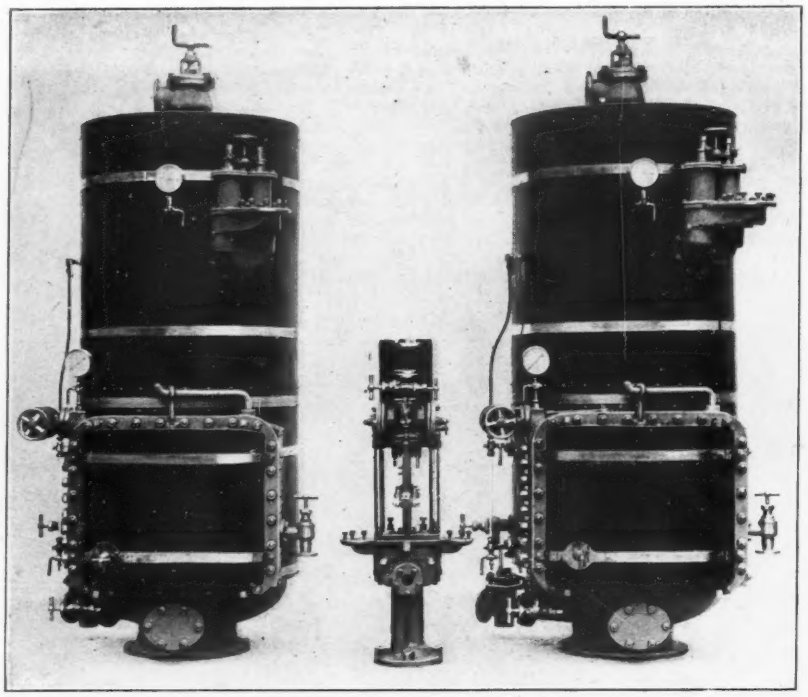

Fig. 22—EVAPORATORS FOR THE S.S. EMPRESS OF IRELAND AND EMPRESS OF BRITAIN—WEIR

Such pumps have been fitted to many ships, and we are informed that the power absorbed in working the air pumps for five battleships shows that the indicated horse-power of these pumps is less than $\frac{1}{500}$ of that of the main engines.

The engraving given in Fig. 20 represents a set of pumps supplied by Messrs. J. P. Hall and Sons, Limited, of Peterborough, to a passenger vessel of 7000 indicated horse-power. On the left side of the illustration is shown the main feed pumps, which are of the direct-acting type, carried on the float control tank, which regulates the supply of water to the boilers as required. The float works automatically and the pump takes the water from the tank, the speed of the former being regulated by the rise and fall of the water in the tank. The central is the ballast pump. The steam cylinder is 9¼in. diameter, the pump cylinder being 11½in. diameter, with an 18in. stroke. It is designed to be capable of delivering 150 tons of water ballast an hour. The small pump on the right is the sanitary pump. This has a steam cylinder 6½in. diameter, and the pump cylinder 5in. diameter and 10in. stroke. The pumps are particularly neat in appearance and substantially made.

Another set of pumps made by the same firm is illustrated in Fig. 19. It has been supplied by Messrs. Hall for an Indian survey vessel. The main feed pump is in the centre of the engraving, and is in combination with the float tank and control gear. The duplex pumps shown on either side are respectively a general service and auxiliary feed pump. On the extreme left is the fresh water pump, and that on the right is the auxiliary pump for the boiler feed, and is of the differential type.

In the matter of pumps of the centrifugal order for circulation as well as ballasting purposes on board ship, the name of Drysdale and Co., of Bon Accord Works, Glasgow, is much too well known to require anything like elaborate reference. Their specialities in the way of circulating pumps can be made to suit, in the matter of design and detail, a wide variety of conditions by slight modification and alteration. Fig. 21 is from a photograph of the twin sets of circulating pumps as erected in the makers' shops, and now being fitted to the Egyptian Mail Steamship Company's liner Heliopolis, recently launched by the Fairfield Shipbuilding Company. These direct-acting centrifugal pumping engines have large bearing surfaces, and are carefully balanced with weights forged to the crank webs. The main bearings are of best gun-metal, and the crank pin and crosshead brasses are of phosphor bronze. All the bearings are made adjustable. The excentric straps are made of gun-metal in the smaller sizes, and are extra broad. The engines are provided with D slide valves. The valve spindle is efficiently guided by means of a substantial guide bracket, and fitted with a cod-piece and adjustable wedge. It is interesting to note that Messrs. Drysdale and Co. have recently fitted the condenser circulating pumps on board his Majesty's new yacht, which was launched by A. and J. Inglis, Limited, on the 30th of May.

Except as regards the method of feeding, the adoption of turbine machinery has not influenced the design of evaporators. Formerly the evaporator was fed by a small pump worked from the air pump levers of the main engines. These features being non-existent in the case of turbine machinery, and, to a growing extent, being dispensed with in the case of modern reciprocating main engines, to give place to the independent working of pumps, the evaporator is now fed either by a small independent feed pump or it can be arranged to be fed from the sanitary tank through an automatic feed box fitted on the side of the shell. Fig. 5 is an example of Weir's latest vertical evaporator with automatic feed regulator. The size of evaporator shown is for 30 tons per day, and is the actual apparatus fitted to the Pacific Steam Navigation Company's s.s. Bogota. With this arrangement, as has been indicated, no feed pump is necessary, as the evaporator can be fed from the sanitary tank so long as there is a sufficient head of water over the float gear, the latter regulating the supply of the feed without requiring any supervision. This Weir type of evaporator is of cast iron, fitted with all requisite mountings, and with the latest form of tube coupling and coil, permitting an easy removal of scale. Fig. 22 illustrates two Weir evaporators, each with a productive capacity of 50 tons of fresh water per day. In connection with these there is an independent direct-acting feed pump 4¼in. and 6½in. by 10in. stroke, with gun-metal water end. These items were supplied to the well-known steamers Empress of Ireland and Empress of Britain.

One fresh item of auxiliary plant on board modern steamers is an oil pump for lubricating bearings and journals. This has been introduced in cases of reciprocating main engines on board not a few steamers, a notable example already referred to being the high-speed enclosed engines fitted to the triple-screw propelled steamer Londres, built by Gourlay Bros. and Co., Limited, Dundee, last year for service on the River Plate. For the most part, however, this class of auxiliary items is new in marine work, and it is

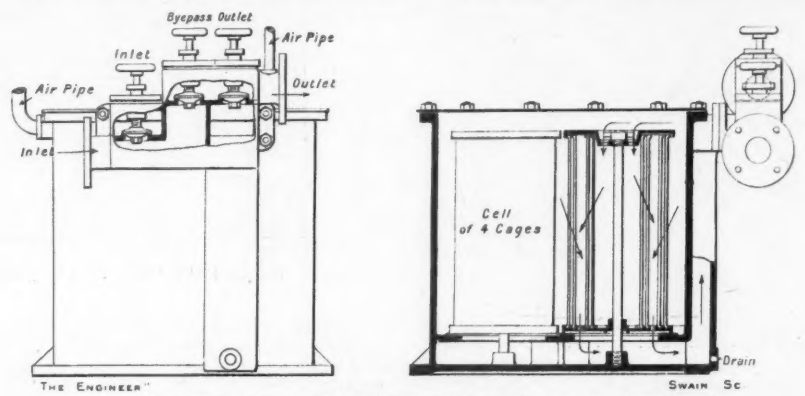


Fig. 23—LIST AND MUNN'S GRAVITATION FEED-WATER FILTER—CARRUTHERS

only since the introduction of the turbine for marine propulsion that these oil pumps have become a general portion of the engine-room equipment. Two are generally fitted—sometimes three—for stand-by purposes, and in the case of the Londres, as well as in most of the turbine-propelled vessels recently turned out, these have been of the Weir firm's single direct-acting type.

The fact that oil within a steam boiler is a source of injury and danger to the boiler has long been generally recognised, and means have been carefully adopted and skilfully devised to counteract the harmful influence, even in the case of slow-speed steamers fitted with engines of ordinary design. But the oil used to lubricate pistons, slide valves, and rods of a reciprocating engine, and carried through with the exhaust steam, and fed into the boiler with the feed-water, is really inconsiderable when compared with the oil, which, but for effective counteracting measures, would be conveyed to the boilers where turbine propulsion obtains. Feed-water filters, therefore, are recognised as indispensable items in the auxiliary installation on board turbine steamers. Various forms of feed filter apparatus have been devised, and are now largely fitted. One form of such apparatus largely in use long before the turbine era, but since its advent improved and rendered increasingly effective, is the gravitation feed-water filter —List and Munn's patent—as manufactured by J. H. Carruthers and Co., Polmadie, Glasgow. Of this filter we give in Fig. 23 a sectional view of a single-tank, four-cell, two-flow, two-strata type, from which the working process may be gathered. Acting by gravity, without pressure, and open to the atmosphere, there is no risk of forcing impurities through the filtering medium. The filtering surface is large, and the speed of water through the filter quite slow. If there is any air in the feed water—another deleteriant to be excluded from boilers—it escapes before the feed-water leaves the filter. The water from the air-pump is discharged at a height which gives sufficient vertical head for propelling the water through the filter. The large filtering surface and the slow passage of the water through it gives every facility for the deposit of grease and oil. Not being under pressure, it may scarcely be necessary to add, neither the gravitation filter nor its fittings are subject to Board of Trade regulations.

The well-known filter and oil separator made by Alley and Maclellan, Polmadie, provides a large amount of filtering surface in a very small space. The arrangement for rapidly and conveniently changing the filtering material—which is of cocoanut fibre mounted on vertical spindles, that can be easily removed and replaced with the minimum amount of bolt-withdrawal and joint-breaking—is a feature much appreciated by engineers-in-charge. In Fig. 24 is given an engraving of the latest form of the filter and separator, simplified by a rearrangement of the large by-pass, formerly a projection on the side of the shell.

A feed-water filter and oil extractor made by Caird and Rayner, of Commercial-road, London, which we illustrate in Fig. 25, can be arranged to be placed in the discharge or suction side of the feed pump, and consists of a cylindrical vessel with a double bottom, into which is

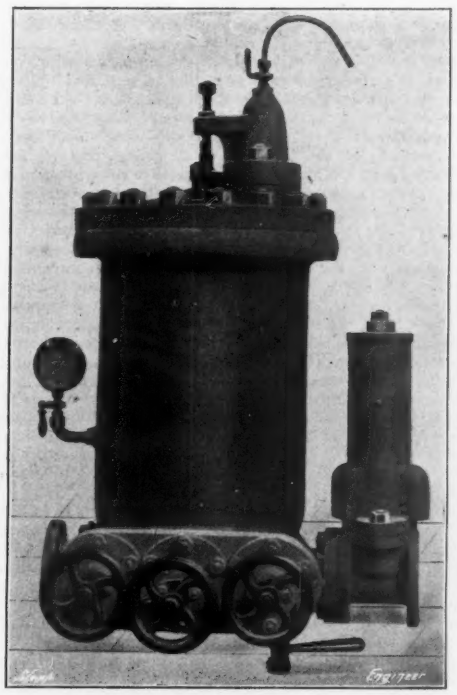

Fig. 24—FILTER & OIL SEPARATOR—ALLEY & MACLELLAN

screwed a series of perforated brass carriers, over which are placed the filtering mantles. These mantles consist of sleeves of filtering cloth drawn over woven coir foundations, and form a very effective filtering medium. The water passes through the mantles into the double bottom, and from thence to the boilers. By-pass valves are fitted to isolate the filter when changing the mantles, an operation which can be performed in a few minutes. With the filter, a steam valve, blow-out cock and pressure gauge are, of course, fitted. One of the special features of this simple filter is the easy manner in which the mantles, after they have been used, can be replaced. To change them, all that is necessary is to take the cover off, as shown in the illustration, when the mantles can then be put in. The filter is of neat appearance.

### SECTION III.—FANS FOR FORCED DRAUGHT AND VENTILATION.

The pumping arrangements in connection with the main agents of steamship propulsion, *e.g.*, feeding the boiler, condensing exhaust steam, &c., as well as with water ballast, and with bilge water due to casualty—in short, the general as well as the special service auxiliaries on board ship having been dealt with, a natural continuation, it may be

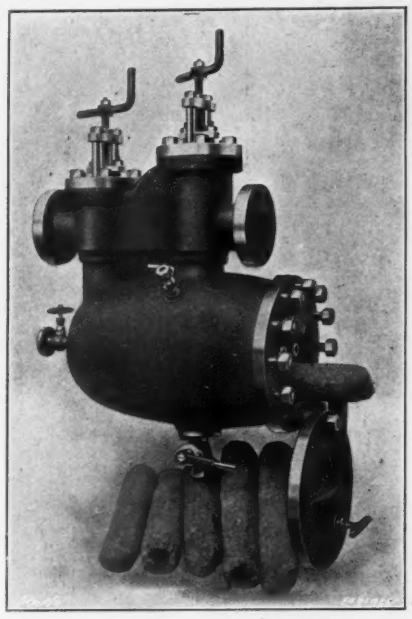

Fig. 25—FILTER AND OIL EXTRACTOR—CAIRD & RAYNER

thought, should consist of the treatment of the auxiliaries —for most part, also stationed in the engine and boiler-rooms—for general and normal service. This has reference to the plant generally serving for the artificial lighting and ventilating of modern high-class steamers. Electric lighting of steamships, however, has for many years been an accomplished thing, and while improvements—great improvements—have undoubtedly been effected, not only in the general system of lighting, but in the plant for generating the current, the most marked feature of development is the accumulation of plant of the same type, broadly speaking, to accomplish the same object, but with minor modifications due to special conditions of service as well as economy in first cost.

For the purposes of the present Supplement, therefore, we do not feel called upon to deal with, or illustrate, the electric generating plant to be found for lighting purposes on board nine-tenths of the ships of Britain's, as well as other nations', merchant fleets. The number of generating units now available to the shipowner or his advisers the shipbuilders and marine engineers, each presenting claims to superiority for particular conditions and service, is legion, and a Supplement of twice the size of the present one would not have sufficed to do justice to this most important branch of marine engineering, which has so revolutionised modern ocean travel.

Although, as stated, we do not propose to deal at length with this subject, we may say that there has recently been constructed a small electric plant to which we should like to refer. The plant, which is illustrated in Fig. 26, is constructed by James B. Petter and Sons, Limited, of 73, Queen Victoria-street, London, and consists of a pair of oil engines and dynamos. The engines are of the Petter horizontal type, working at 240 revolutions per minute, and direct coupled to dynamos having an output of approximately 5000 watts, which is sufficient for eighty 16 candle-power lamps. The plant was erected on board the s.s. Ghazee, owned by Messrs. Gellatly, Hankey and Co., and special precautions have been taken by the makers to prevent fluctuations during rough weather, and also any escape of oil. We are given to understand that the plant has been in use for about twelve months now, and during that time has, it is stated, worked very satisfactorily.

Electricity for power purposes on board ship is what we aim at directing some attention to, and as the new motive power as applied to forced draught for boiler furnaces is now competing with the older steam power, it is proposed to illustrate a few examples in both departments. In addition to this, electricity on board ship is being applied for power purposes in widely ramified directions. The demands for superior ventilation (on a large scale in the case of mail and passenger steamers and produce-carrying steamers) is only one of the directions in question. The noiselessness of working, and the perfection of despatch arrived at in working cargo and the steering gear of different classes of merchant vessels, constitutes another such direction.

Dealing with the most important of these branches, the matter of forced draught for boiler furnaces now calls for some treatment. While fans for forced draught in the boiler room, as well as for ventilating and heating purposes in other parts of modern steamers, are still to be found individually driven by independent high-speed steam engines, it is chiefly on account of electric power being available that in many steamers the increasing employment of fans for a growing variety of purposes has been brought about. Motor-driven fans, large and small as part of a general system with electricity as the motive power, are now as plentiful as, not so many years ago, they were rare and remarkable on board ship. While in some cases fans and motors are found, owing to the exigencies of situation and particular duty, entailing separate generating plants in different parts of a vessel, they are to a large extent integral portions of the systems taking motive power from the main generating plant erected in or about the engine-room. No doubt in very large vessels, carrying passengers as well as produce, and on long ocean services, it is quite an approved practice to adopt small units, each of which takes care of a certain portion of the vessel although this has the disadvantage of divided, and possibly insufficient attention.

Fig. 27 shows a steam driven fan for forced draught, made by W. H. Allen, Son and Co., Ltd., the engine being of the firm's high-speed forced lubrication enclosed type.

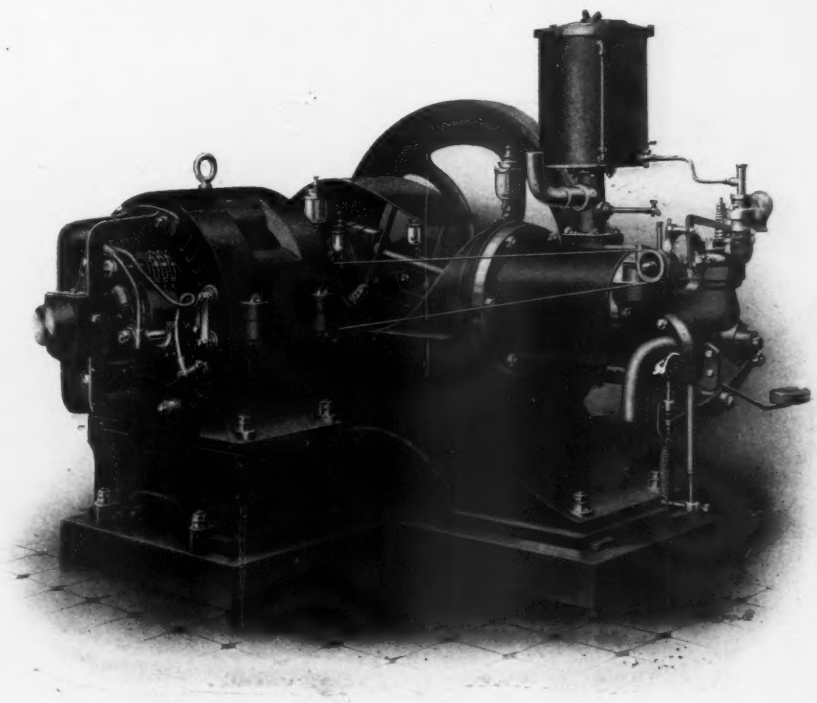

Fig. 26—ELECTRIC GENERATING PLANT DRIVEN BY OIL ENGINE—PETTER

This combination is exceedingly small and compact for its power. The weight of the fan is carried upon the outer bearing of the steam engine, this latter being of specially substantial design. The matter of lubrication has been well looked after. The fan in this case is made of mild steel plate, but under special circumstances the makers construct these fans of high-tension sheet brass, where there is a possibility of corrosion from salt spray. Fig. 28 illustrates a steam-driven fan enclosed in a special casing, the engine in this instance being of Allen's open type. This is a combination which has found much favour in the mercantile marine. Fig. 29

shows an Allen motor-driven forced-draught fan. In this case the motor is of the totally enclosed type, the casing being entirely dust-proof. The electrical design of the motor has been adapted to enable the machine to run at an exceedingly high temperature without damage resulting to the insulation. These motors have, we are told, run for long periods in an atmosphere of 180 deg. to 200 deg. Fah., and have given entire satisfaction. The motor is provided with all the necessary accessories in the way of inspection doors and lubricating arrangements, the upper half of the commutator cover being cast in aluminium to facilitate its removal. On the right of the picture is shown one of Messrs. Allen's special design of controller for this class of work, by which good speed regulation is provided for the motor, as well as the usual overload release. An ammeter is also arranged in close proximity to the starting handle.

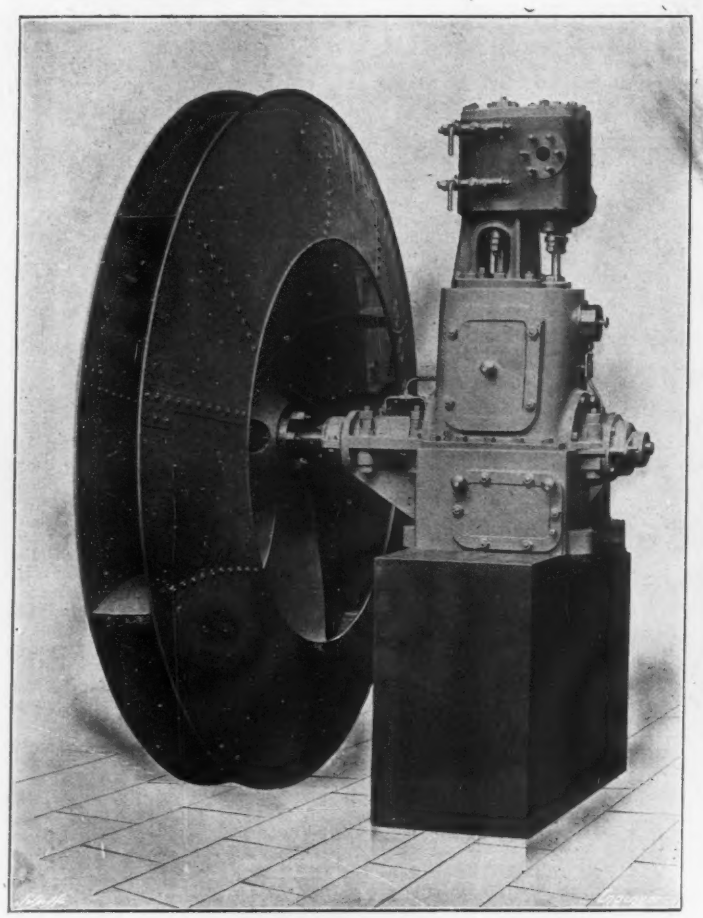

Fig. 27—STEAM DRIVEN FAN FOR FORCED DRAUGHT—ALLEN

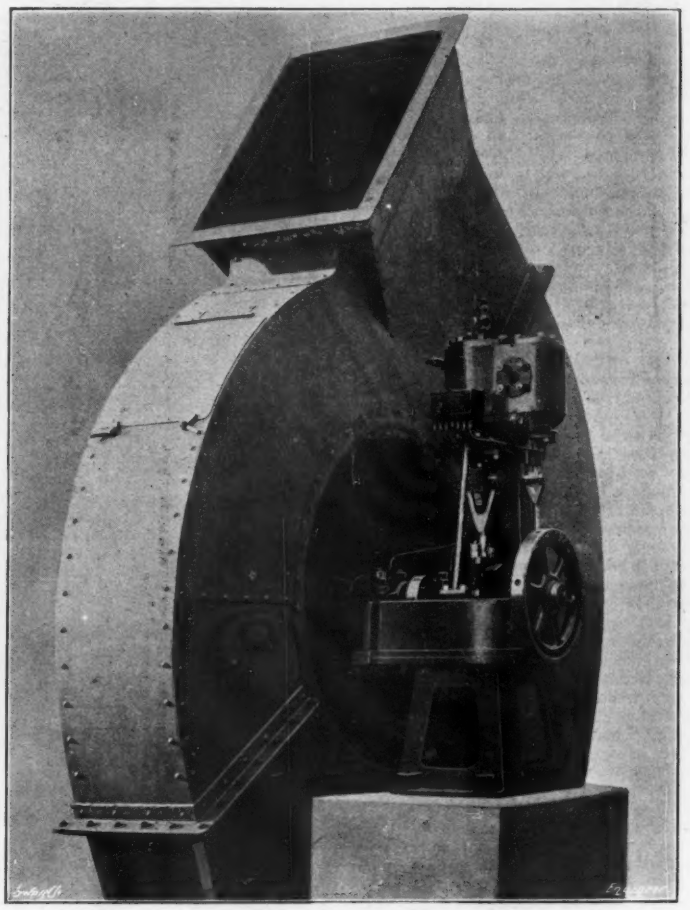

Fig. 28—FAN DRIVEN BY OPEN TYPE ENGINE—ALLEN

A Brotherhood engine with fan, for forced draught, or ventilation, is illustrated in Fig. 30. This high-speed engine is very silent in working and minimises the cost of renewal of bearings. Fan engines and fans of specially light design for torpedo boats, torpedo destroyers, &c., are a well-known speciality of this firm.

A single-crank, single-acting compound Chandler patent engine, coupled to a double inlet steel-cased fan is shown in Fig. 31. This plant was designed for forced draught on board ship, a class of work in which Bumsted and Chandler have specialised. The engine in the illustration is single crank and compound, the high-pressure cylinder being placed immediately above, and tandem to the low-pressure cylinder.

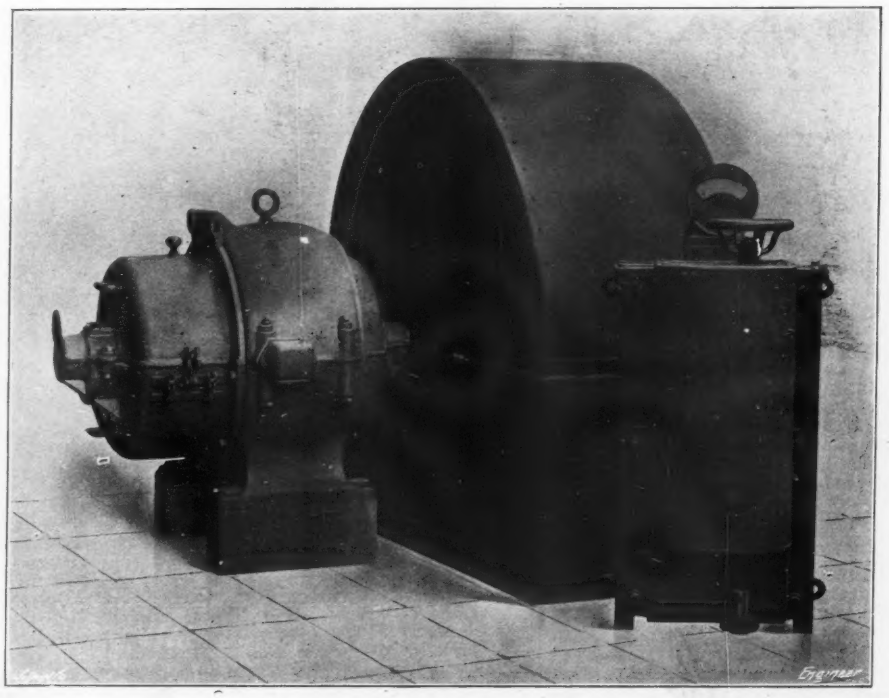

Fig. 29—MOTOR DRIVEN FORCED DRAUGHT FAN—ALLEN

The fan runner is of steel plate fixed to a fan centre of cast iron, which in turn is securely keyed upon an extension of the engine crank shaft. The construction of the fan runner is as follows:—The blades, which are of a number suited to the special work which each fan has to perform, are pressed to the proper shape and flanged; they are then riveted to a stiff steel centre disc, equal numbers being fixed to either side of it, which previously to this had been turned true and bored to fit on to a mole turned upon the centre casting.

The fan casing is usually built completely of sheet steel, well strengthened with angle iron wherever deemed necessary. In some cases, as in the illustration, the casing is composed of a belt of cast iron, to which is bolted the remainder of the casing, which is of steel. The base-plate upon which the engine rests is of cast iron, and to this, as will be observed, the fan is bolted. Great care is exercised in providing ample bearing surface for the crank and fan shafts, and we are informed that such fans and engines have run from twelve to eighteen months without stopping—this has been when used for ventilating colliery workings. The following particulars of a test taken on a plant similar to that illustrated in Fig. 31, but smaller, may prove interesting. The test lasted for four hours, during which readings were continually taken at regularly stated intervals. These are the mean results:—Boiler pressure, 150 lb. per square inch; vacuum, 26in. in condenser; revolutions per minute, 400; air pressure at outlet, 6⅛ in. of water; indicated horse-power, 21; average water consumption, 20·65; lb. of water per indicated horse-power per hour, horse-power in air, 13·47; engine efficiency, 90 per cent.; fan efficiency, 72·3 per cent.; combined efficiency, 65 per cent. The boilers were 52ft. away from the engine, and the condenser was about 20ft. away. When these facts are considered, and also the small size of the engine and fan, the above figures may be considered as satisfactory.

Fig. 32 is from a photograph of a double-acting forced lubrication single-crank compound high-speed engine coupled to a centrifugal pump for pumping condenser circulating water. The pump impeller is keyed directly to an extension of the engine crank shaft; the engine is fitted with a by-pass, by means of which it is able to develop an overload for short periods, steam of initial pressure being passed into the low-pressure cylinder.

The figures following are taken from a test of this pump. We give them, as they are interesting, and show that both engine and pump are of efficient design:—Quantity of water, 3500 gallons per minute; head of water, 41·8ft.; revolutions per minute, 431; steam pressure, 140 lb.; indicated horse-power, 70; water horse-power, 44·3; brake horse-power, 61·95; combined efficiency, 66·3 per cent.; pump efficiency, 71·8 per cent.

For the reason that they occupy small space relatively to the duty they are capable of performing, the Sirocco fans, which are the speciality of Davidson and Co., Limited, Belfast, are extensively used on board ship. Reliable and highly efficient in operation, they form, when direct coupled to electric motors, a very compact and neat combination. One of the smallest of these consists of a fan of the universal discharge type, *i.e.*, it can be adjusted to blow in any desired direction, and measures only 20in. by 19in. by 24in. high, and has a capacity of 1000 cubic

feet of air per minute when running at a speed of 1300 revolutions per minute. Many of these little sets have recently been supplied, amongst other vessels, to the battleship Dreadnought. Small fan units can be put to many different uses on boardship, and the Davidson firm supplied the turbine Allan Line steamers Victorian and Virginian with four sets arranged on the open deck, to exhaust air from lavatories, closets, and alleyways, while

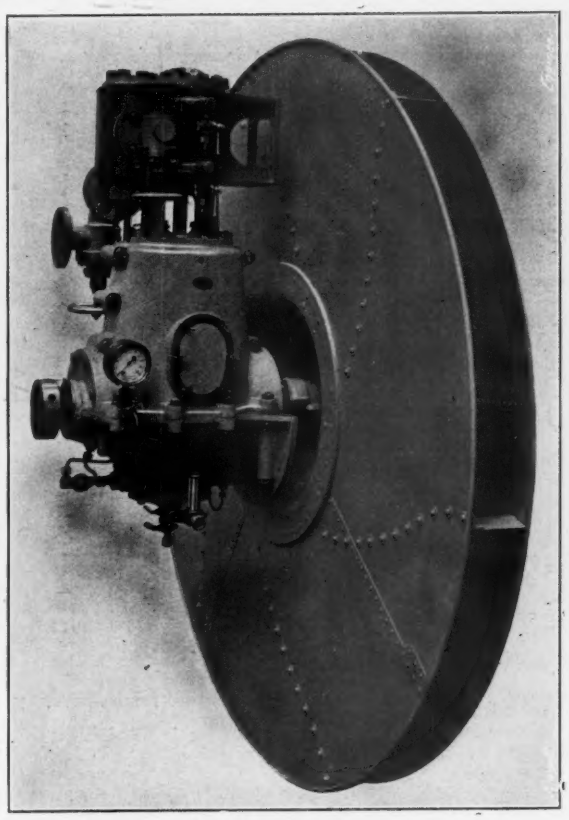

Fig. 30—STEAM DRIVEN VENTILATING FAN—BROTHERHOOD

n the same vessels fans were put in for blowing air into pantries, store-rooms, &c. These units operate independently all the general ventilation and heating scheme, which consisted of the "thermotank" system as fitted to very many of the largest mail and passenger ships built within recent years by Messrs. Stewart, of Glasgow. Sirocco fans were employed to blow and exhaust the air through the apparatus and ducts. The "thermotank" system has been applied to all the latest Cunard liners, including the Lusitania and Mauretania, although not always involving the use of the special make of fan above alluded to.

Apart from the large question of the necessity for

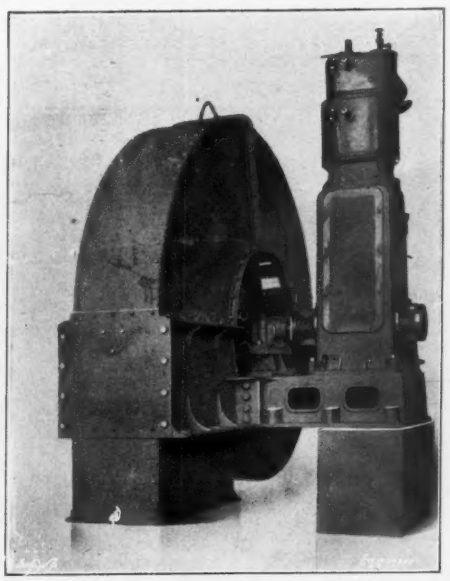

Fig. 31—FORCED DRAUGHT FAN—BUMSTED & CHANDLER

mechanical refrigeration on board ship for dead meat and such cargoes—which will afterwards be dealt with—the great amount of less perishable goods imported into this country from all parts of the world is a matter which entails care and thoroughness in the ventilation equipment of the holds of cargo vessels. In this alone there lies a considerable field of utility for fans, and the number of firms providing the necessary apparatus is large. Small electrically-driven fans are supplied for ventilating the holds of grain-carrying ships when it is necessary to keep the temperature low to avoid fermentative heating of the grain. Fans are also employed with success on board cattleships when ventilation—other than that obtainable through natural means, which in cattle ships, as in passenger vessels, appears so often a minus quantity—is specially necessary when valuable cattle and horses are carried in tropical latitudes. Besides the fans of the centrifugal type erected for such purposes, the practice is also extending of fitting fans of the "propeller" type for such classes of ventilation as require only light air pressures. While very suitable for providing additional ventilation, or for extracting vitiated air from small cabins, alleyways, &c., the propeller type of fan, however, is not adequately adapted for ventilation through long or tortuous ducts on board ship.

In Fig. 33 there is illustrated a sea-water evaporator having somewhat interesting features based on principles which, although referred to by such authorities as Professor Macquorn Rankine, Osborne Reynolds, &c., have not hitherto been prominently brought into practice in the manufacture of evaporators and heaters. We hope to draw adequate attention to this apparatus and the principles which it in practice apparently will embody, in a future issue. Meantime we may simply say that the principles have been applied to water heaters and evaporators of Andrew's and Cameron's make with marked success. The firm has supplied a considerable number of both evaporators and heaters to many of the well-known steamship lines engaged in passenger and cargo service, as well as in high-class steam yachts. Sea-water evaporators which have been at work since the beginning of 1903 have not only required little cleaning and attention, but have maintained their specified production with remarkable regularity. Feed-water heaters are made with copper coils in the same way as the evaporators, and have facilities for withdrawing the coils for cleaning or examination, so that they are in all respects as handy as the modern evaporator.

A complete distilling plant—shown in Fig. 34—consisting of evaporators, distilling condensers, pumps, &c.—Quiggin's patent—which the Liverpool Engineering and Condensing Co., Ltd., fitted on board the turbine Cunard liner Carmania and her reciprocating predecessor, Caronia, for the production of drinking water on board, is being erected on a correspondingly large and improved scale on the steamers Lusitania and Mauretania. Each set consists of the following:—Two evaporators for feed make-up, to work single or compound effect; one evaporator for drinking, cooling, and washing water; two distilling condensers, circulating, feed, and brine pumps, and eater for evaporator feed. The evaporators and mountings are made of rolled naval brass and gun-metal.

An exhaust steam feed-water heater with patented triple-thread coils is illustrated in Fig. 35, and this particular heater will work, it is said, equally well whether it is placed horizontally or vertically. A high-pressure feed-water heater also made by the Liverpool Engineering and Condensing Company, Limited, is shown in Fig. 36.

There is illustrated in Fig. 37 a Quiggin's heater condenser, specially designed for turbine propelled ships. The upper part R acts as a feed-water heater, and the lower surface W deals with any steam which has not been condensed in the upper coil or heating surface. The feed-water passes in at I and through the upper surface, finally emerging at O to the boilers. The coils are enveloped with exhaust steam which enters at S, and this heats the feed-water. The lower part is of the ordinary condenser straight-tube type; the cold water passing through this surface in at C and out at D is supplied by the main or auxiliary circulating pump. It will thus be noticed that this machine has the two-fold advantage of heating the feed-water and condensing and cooling the exhaust steam which passes away at K, at a low temperature, to a gravitation filter which is shown in combination with this machine in Fig. 38. Here T is the heater condenser and G a Quiggin's feed-water filter of the suction or gravitation type through which the condensed exhaust steam passes on its way to the feed tank H. The turbine condensed steam from the air pumps delivers into this feed tank at A. This steam, being practically free from grease, is not usually filtered. The auxiliary steam is the portion in turbine steamers which contains practically all the grease, and, therefore, it is very desirable thoroughly to cool it before filtering in order to coagulate the oil. The feed pump F, which is automatically controlled by the usual float arrangement, draws the filtered water from the tank H, and delivers it through the upper feed heating surface to the boiler.

In the next engraving, Fig. 39, we reproduce an illustration of a condenser made by the firm of J. P. Hall and Sons, Limited, of London Road Works, Peterborough. The apparatus is designed as an auxiliary condenser for vessels of the merchant type, and is fitted with circulating and air pumps of the firm's own make.

The firm of Royles, Limited, of Irlam, manufactures Row's patented indented tubes, which are eminently suitable for marine purposes, as they are very efficient and cast the scale readily, rendering cleaning operations simple and speedy. Fig. 40 shows an evaporator made by Royles Limited, in which Row's tubes are employed. For some time these appliances have been used not only in mercantile marine, but also in the Navy. As will be seen from the illustration the evaporator is so arranged that the tube battery can be got at with a minimum amount of trouble. The tubes are arranged so that by opening the door they are brought out of the evaporator, as shown in the engraving. They are then quite accessible, and can be cleaned without the necessity of having to break any pipe joints. The battery is built up of a number of sections, which are threaded on to two steel bolts and held together by closing caps.

Calorifiers have long been a speciality of Royles, Limited, and the engraving—Fig. 41—illustrates one of their best examples of these. It is a Row's patented

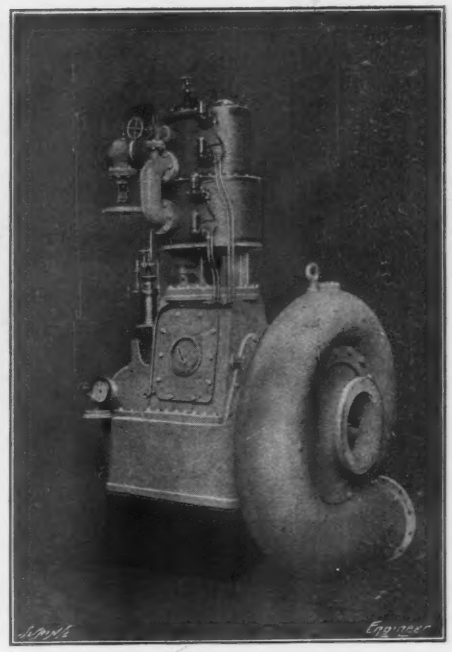

Fig. 32—CENTRIFUGAL PUMP—BUMSTED & CHANDLER

calorifier fitted with Royles automatic steam control device. Its most frequent use on board ship is for supplying hot water to bath rooms and lavatories, because, when the demand for hot water is not regular, then such a storage calorifier becomes more useful, if not quite a necessity. The apparatus consists of a cylindrical casing of either mild steel or copper, and the Row tube heating surface is arranged inside the lower part of the casing, thus combining calorifier and storage in the same appliance. It is mounted on the cast iron cover plate, which enables it to be easily withdrawn for inspection, and

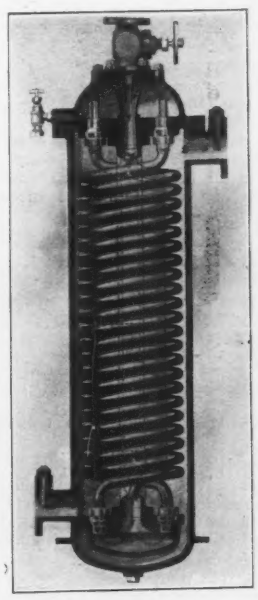

Fig. 33—SEA-WATER EVAPORATOR

there is no necessity to break any of the pipe joints. Other provision, too, is sometimes made for cleaning by having an auxiliary manhole and cover on the side of the casing, but this is only necessary where the calorifier has to treat very bad waters. For flow and return pipes bosses are provided on the top of the casing, as shown. The Royles patented automatic steam control gear, which is fitted, is compact and sensitive in its action.

Messrs. Holden and Brooke, Limited, of West Gorton, Manchester, have brought out a feed-water heater which they claim delivers the feed fully 20 deg. Fah. hotter than the ordinary type of heater. In fact, they guarantee, at maximum capacity, feed-water at a temperature of 200 deg. Fah., and when this maximum is not required they

state that a still higher temperature is obtainable. In Fig. 42 we illustrate a plan showing the application of this "high velocity" feed-water heater to a river steamer having a non-condensing engine, and working in very muddy water. The end elevation shows the pipe connection attachment to the casing side and special arrangement for blowing out sediment from the inlet and outlet settling chambers and the valve for draining the tubes when the heater is not at work. From the sectional elevation of the heater, it will be noticed that the feed-pump delivers into the upper portion of the heater, the water being deflected downwards by a projecting rib. The inlet of the heater is through the uppermost tube, so that all the space below this forms a special sediment collector. The arrangement of the tubes should be noted, for it is such that the water has to pass through many tubes, and this at a high velocity; in fact, it has to traverse as many as twenty-four tubes before coming out at the top of the outlet tube. The water, on leaving, is again deflected downwards so as to cause the sediment to gravitate into the outlet sediment chamber.

It frequently occurs that some of the boats in which these heaters are fitted only run for an hour or so at a time. In such cases it is necessary to open for a few moments the valves D and E, one at a time. This allows the feed delivery to be discharged overboard, and effectively to clear out the sediment which has settled in the settling chambers during the period of stoppage. On stopping the main engines it is usual to open the valve F which drains the tubes, there generally being sufficient internal pressure to empty these. Although the heater is shown in the illustration arranged with a non-condensing engine, the same arrangement is quite applicable with a live steam heater.

The illustrations given in Fig. 43 were made from a photograph taken of a small model of Green's patented balanced valve cut to show the method of operating. This valve is also made by Messrs. Holden and Brooke, Limited, and it is claimed that it is particularly suitable for turbine machinery. The special features appear to be that the valves are independent, and consequently each valve can seat itself properly without affecting the other.

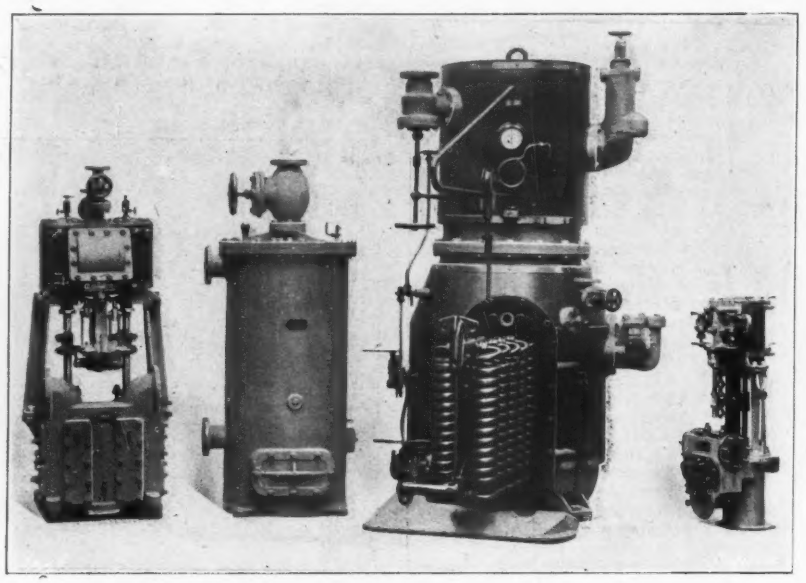

Fig. 34—DISTILLING MACHINERY, S.S. CARONIA AND CARMANIA

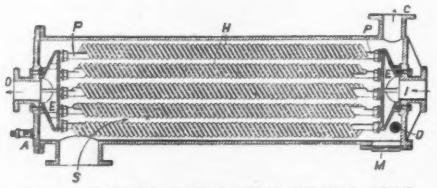


Fig. 35—HEATER WITH TRIPLE THREAD COILS

Neither valve is opened against pressure. The valve faces of both valves are protected against the cutting action of the steam, the smaller valve being provided with a special protected seating, whilst the large valve always being in balance whilst opening needs no protection. And the load on the operating spindle is, it is said, very small. The illustration almost explains itself. There are two valves employed, the smaller valve having the pressure on the under side, while the large valve has the pressure on the top. Thus the smaller valve, on putting the operating gear into motion, is the first to open, and it continues opening until it is checked by a stop on the valve casing. Then the larger valve commences opening, and it will be seen that when this takes place it is in equilibrium. On closing exactly the reverse action takes place. The valve in the centre of Fig. 43 shows the smaller valve open and the larger one closed. In the right-hand view they are both in equilibrium, and in the left-hand view they are shown fully open.

Another valve of interest is that made by Royles, Limited of Irlam, near Manchester, and illustrated in Fig. 44. It is a combined reducing and safety valve. This is a good combination, for many serious accidents have occurred due to not using a safety valve in conjunction with a reducing valve. The main valve is balanced by what may be called an elastic cylinder and piston, instead of by some arrangement of diaphragm. The safety valve is shown at the top of the valve in the engraving, and the side springs pulling on the horseshoe-shaped piece, applies the required pressure. The load on the valve can be easily adjusted by turning the small hand wheel shown above the valve, and the reduced pressure can readily be varied. Both the alteration of reduced pressure and the resetting of the safety valve are carried out at one operation.

The demand for steamers of the tank description for carrying oil in bulk has been greatly stimulated by the increasing relaxation of the Suez Canal regulations for the passage of steamers of this class through that great waterway, conjoined to the great increase in the consumption of petrol for motoring purposes. Quite recently it has been reported that as many as seven or eight large shipowning firms have been asking tenders from shipbuilders for new tonnage of this class. Of course, improvements both in design and equipment have also contributed to the favour—or shall we say toleration—with which "tankers" have come to be regarded by the Suez Canal authorities and by a wider circle of shipowners. The system of ventilation which has been introduced for some years, and which is associated with the pumps and piping involved in discharging the oil cargoes, and identified to a large extent with the names of Mr. Stephen H. Terry and Sir Fortescue Flannery, and as fitted on board all ships of the fleet owned by the Shell Transport Company, has materially helped on the present stage of development in carrying of oil in bulk. The system in question, briefly described, consists of putting in extra large suction and discharge mains for the oil, which are fitted in duplicate and range in diameter from 10in. to 12in.—a more adequate provision as regards this than obtains to-day even in many larger steamers engaged in ordinary service. These are used for loading the oil, and as soon as the oil is discharged they are utilised for sucking the petroleum vapour out of the holds. Petroleum vapour being three times as heavy as air and twice as heavy as carbonic acid gas, the idea at first tried of blowing air into the holds in order to get rid of the petroleum vapour was soon abandoned. Now, the system of suction pipes which serve to load the oil is used for drawing out the impure vapour by coupling up the mains to highly efficient fans, specially designed for this work.

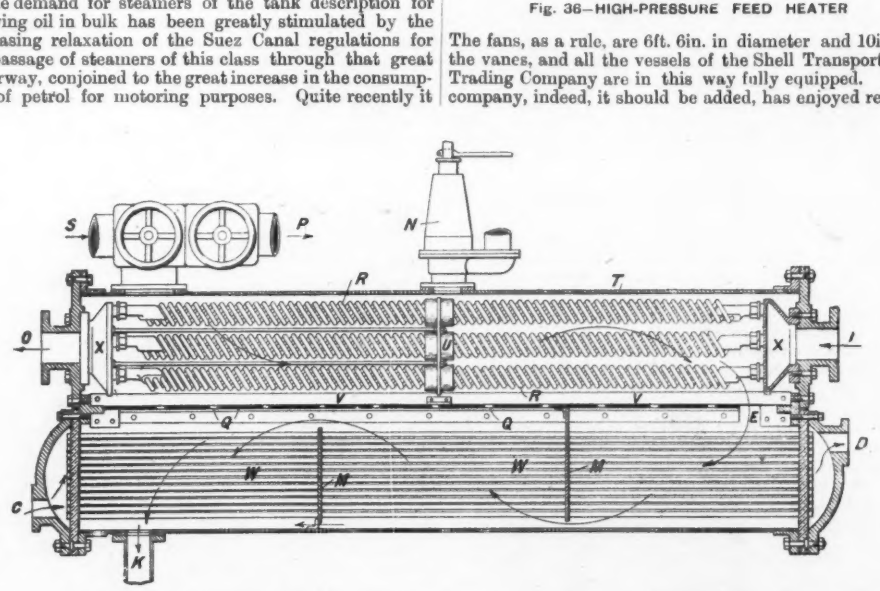


Fig. 37—COMBINED HEATER AND CONDENSER—LIVERPOOL ENGINEERING & CONDENSING CO.

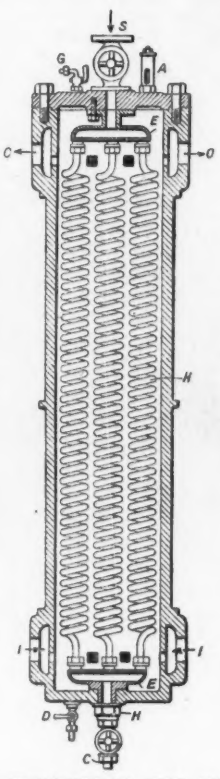


Fig. 36—HIGH-PRESSURE FEED HEATER

The fans, as a rule, are 6ft. 6in. in diameter and 10in. on the vanes, and all the vessels of the Shell Transport and Trading Company are in this way fully equipped. This company, indeed, it should be added, has enjoyed relaxations of the general regulations imposed by the Canal authorities since about 1892-3, when the vessels began to be equipped in this manner.

For disposing of the ashes and general refuse from the stokehold of steamers of any considerable size and boiler power steam hoists have for many years been common, and several makers furnish very capable and quiet work,

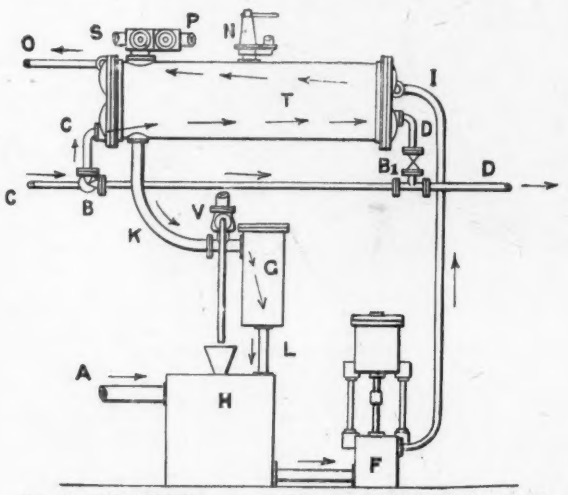


Fig. 38—ARRANGEMENT OF HEATER AND GRAVITATION FILTER

ing machines. Fig. 45 illustrates the improved steam ash hoist now being supplied by Alley and Maclellan, Polmadie, Glasgow, the newest feature being the automatic control motion. This motion is very similar to that of a steam steering gear. So long as the operator keeps turning the small wheel shown on the front of the machine, the buckets will be raised or lowered just according to the direction in which the wheel is being turned, and, with the stoppage of the wheel motion, there is simultaneously a stoppage of the buckets. Means are also provided for preventing any possibility of overwinding, in that stoppers are fixed in such a way that whenever the proper height has been attained the attendant is prevented turning the wheel further. The buckets are thus raised to the required height or lowered gently to the stokehold floor, without the slightest fear of undue jar or excess of motion in either direction.

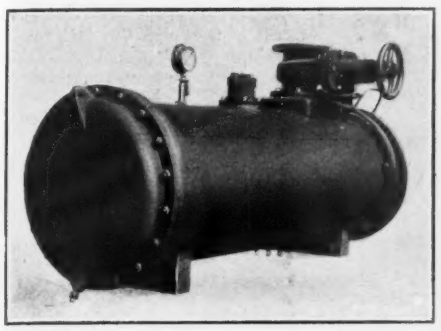

Fig. 39—AUXILIARY CONDENSER—HALL

Atmospheric or pneumatic hoists for dealing with stokehold ashes with mechanically operated parts are now largely adopted.

### SECTION IV.—REFRIGERATION AND VENTILATING PLANT ON BOARD SHIP.

The storage and overseas carriage of refrigerated produce, animal as well as vegetable, now forms an extremely important branch of commerce, and will undoubtedly extend as time goes on. This need not be insisted upon; suffice it to say that apart from its vital interest for marine engineers—many of whom have the responsibility of maintaining and working the valuable mechanical plants involved, and the still more valuable cargoes—it has a close interest for the general public, for those who "stay at home at ease," as well as those who go "globe trotting." The British public now largely depend for food upon the dead meat and natural produce carrying trades, and the passengers and crews of ocean-going steamships are quite as dependent, and even more lavishly expectant. That it is of imperial interest is proved by its having materially helped the feeding of our soldiers in South Africa during the late war, and its being now in constant requisition by the crews of our merchant ships, as well as of our naval fleets.

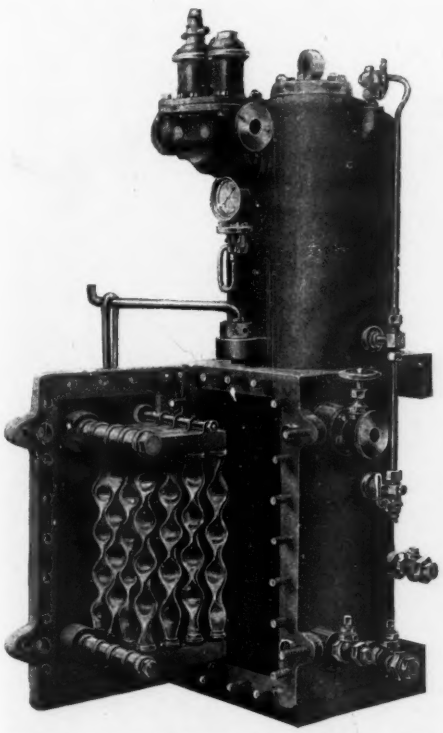

Fig. 40—EVAPORATOR OPEN FOR CLEANING—ROYLES

For the preservation of provisions and the present lavish scale of victualling on large passenger vessels it would be impossible to provide without the aid of mechanical refrigeration. Steam-driven machines are in general use in the merchant service, but electric driving, either through gearing or by direct coupling, is becoming general in the case of war vessels. The carbon dioxide system of refrigeration, which is most generally adopted for all marine purposes, was first introduced into this country in a practical form about eighteen years ago by J. and E. Hall, Limited, Dartford. This firm has specialised the system, and almost entirely confined its attention and the resources of its works to its development. The success of this policy has been undoubted, and the company's output of $CO_2$ machines during the last twelve months has exceeded all previous records. The total has been swelled recently by four particularly large plants on s.s. Manchester City, Guardiana, La Blanca, and El Argentino, which, in addition to size, have features of somewhat special interest. All the vessels mentioned have cooling capacity for frozen and chilled meat larger than that on any other vessel afloat. The average measurement of the insulated spaces on these four vessels is nearly 400,000 cubic feet. We illustrate—Fig. 46—one of a pair of large single compressor machines with tandem compound engine, fitted on s.s. La Blanca. The brine-circulating arrangements on these vessels have been particularly well thought out, the power of the pumps, the size of the mains, and the number of separate circuits being quite exceptional. The two machines are quite independent, but arranged for combined work. The makers' special brine-mixing system, to enable the two temperatures required in the chilled and frozen spaces respectively to be maintained, has been provided, and has worked admirably, giving perfect control of the temperature within a limit of variation of 1 deg. Fah.

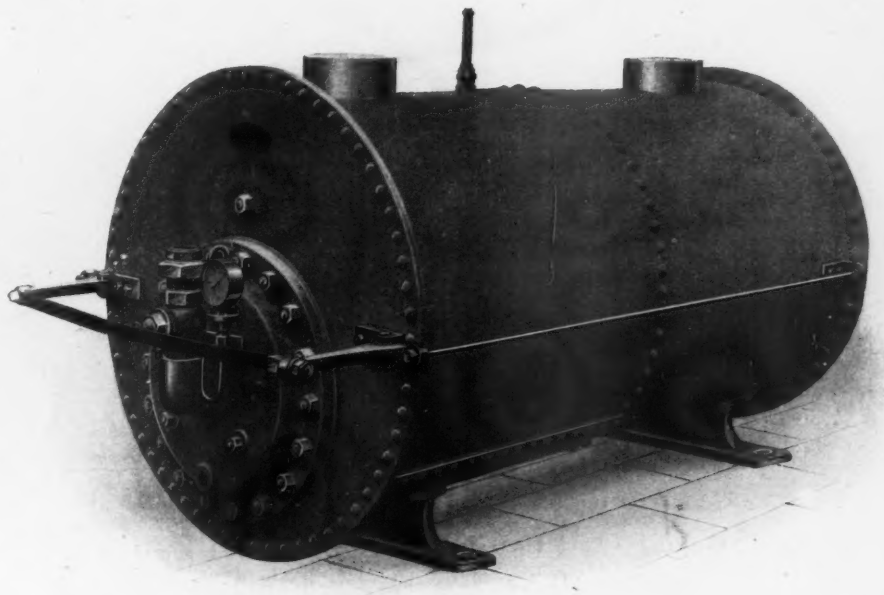

Fig. 41—STORAGE CALORIFIER—ROYLES

A new type of vertical duplex machine has recently been produced by J. and E. Hall, Limited, of which we give an illustration—Fig. 47. This machine occupies the minimum of space for its type in proportion to its refrigeration power. The running is smooth and noiseless, the two compressors being driven by compound steam cylinders through a four-throw crank shaft. The compressor bodies are of the makers' standard type, bored from solid blocks of hard forged steel and are double-acting. The brine and water pumps are of the duplex type. Machines of this design were fitted during 1906 on s.s. Falaba and Abertville, belonging to the fleet managed by Elder, Dempster and Co., Liverpool.

The Haslam Foundry and Engineering Company Limited, Derby, since its incorporation with Pontifex and Wood, London, about 1892, has largely dealt with ammonia absorption refrigerating, but it also makes $CO_2$ machines, as well as the non-chemical machines in which compressed air is the principal agent. Each system has its advantages, which need not, of course, be here dwelt upon. Fig. 48 is an illustration of the $CO_2$ refrigerating machine as manufactured by the company and fitted on the turbine steamers Victorian and Virginian of the Allan Line fleet. In the engraving Fig. 49 we reproduce one of the same company's $NH_3$ machines with compound ammonia compressors and compound steam cylinders, such as it has fitted on board the New Zealand Shipping Company's steamers. The firm has also a make of $NH_3$ triple compressor machine with triple-expansion steam cylinders, which it has fitted on the Nelson Line steamers and which is now being fitted on the Turner Brightman steamers.

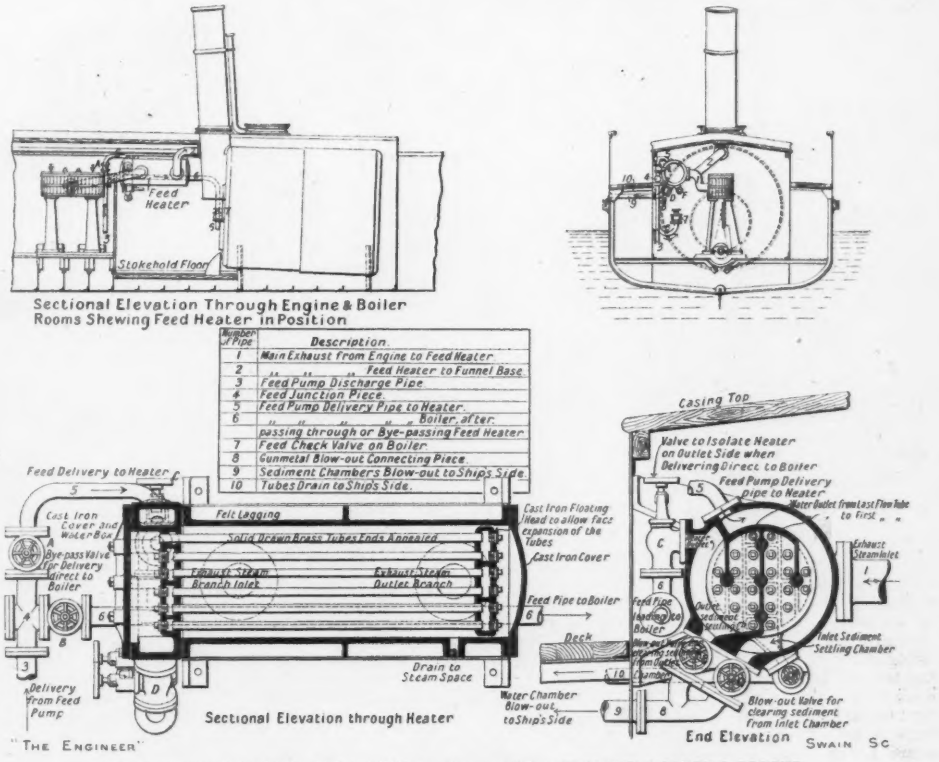
Feed Heater
Stokehold Floor
Sectional Elevation Through Engine & Boiler Rooms Shewing Feed Heater in Position
Number of Pipe | Description
1 | Main Exhaust from Engine to Feed Heater
2 | " " " Feed Heater to Funnel Base
3 | Feed Pump Discharge Pipe
4 | Feed Junction Piece
5 | Feed Pump Delivery Pipe to Heater.
6 | " " " Boiler, after passing through or Bye-passing Feed Heater
7 | Feed Check Valve on Boiler
8 | Gunmetal Blow-out Connecting Piece
9 | Sediment Chamber's Blow-out to Ship's Side
10 | Tubes Drain to Ship's Side.
Feed Delivery to Heater
Cast Iron Cover and Water Box
Bye-pass Valve for Delivery direct to Boiler
Delivery from Feed Pump
Felt Lagging
Solid Drawn Brass Tubes Ends Annealed
Exhaust Steam Branch Inlet
Exhaust Steam Outlet Branch
Drain to Steam Space
Cast Iron Floating Head to allow Free expansion of the Tubes
Cast Iron Cover
Feed Pipe to Boiler
Deck
Water Chamber Blow-out to Ship's Side
Sectional Elevation through Heater
Casing Top
Valve to Isolate Heater on Outlet Side when Delivering Direct to Boiler
Feed Pump Delivery Pipe to Heater
Water Outlet from last Flow tube to First " "
Exhaust Steam Inlet
Feed Pipe leading to Boiler
Inlet Sediment Settling Chamber
Blow-out Valve for clearing sediment from Inlet Chamber
End Elevation
"THE ENGINEER"
SWAIN Sc

Fig. 42—HIGH VELOCITY FEED HEATER ON A RIVER STEAMER—HOLDEN & BROOKE

same machines are also used for carrying chilled meat on board ship, brine pipes being suspended in the 'tween decks through which the cold brine is circulated.

The ammonia refrigerating plant of the Pulsometer Engineering Company, Reading, seems to embody the three essential features that appeal with so much force to marine engineers—viz., simplicity, reliability, and low cost of maintenance. In support of the claim of the

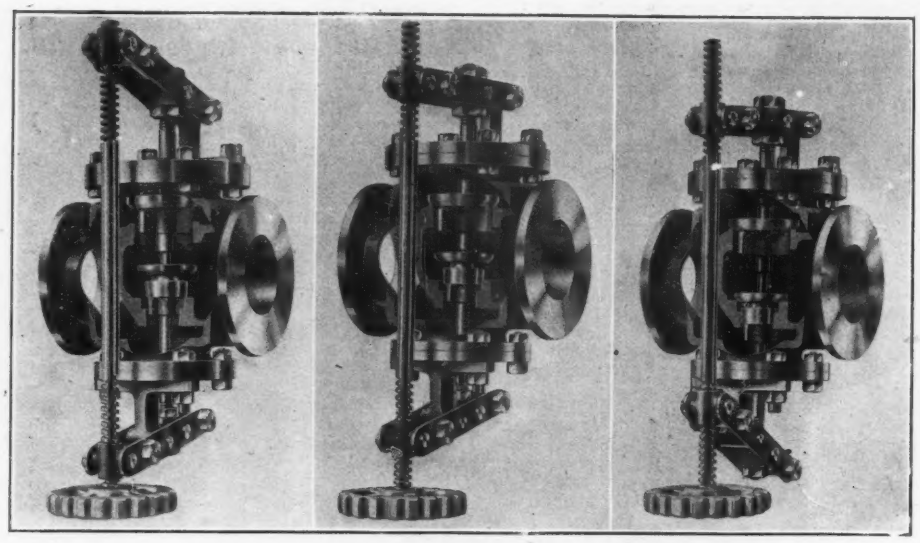

Fig. 43—BALANCED VALVE FOR TURBINE MACHINERY—HOLDEN & BROOKE

makers as to the very small loss of refrigerant where their plants are employed, they inform us that they have had ships' plants running for twelve months at a time without any replenishing whatever of the ammonia. This result is, it is said, due to the special design of the compressor, and to the employment of the company's improved fittings cut from the solid steel bar. Fig. 51 represents the plant just fitted to the s.s. City of London, recently launched for the City Line by Workman, Clarke and Co., Belfast. Many repeat plants have been supplied by the company to this line of steamers since it fitted the first vessel in 1898. In the Navy, it may simply be added, the company's success has been even more marked, it having fitted some seventy of H.M. vessels with its refrigerating plant.

Of the ammonia compression plant fitted on the City

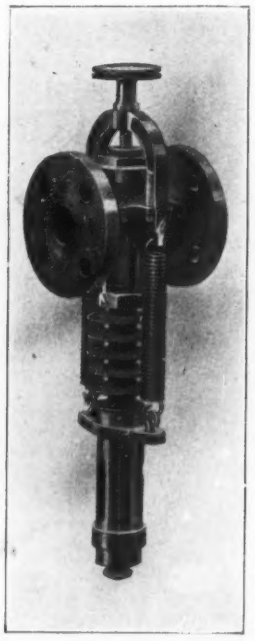

Fig. 44—REDUCING AND SAFETY VALVE—ROYLES

of London, and of the system generally, a brief account may be given. The compressor plant cools the brine in the refrigerator, which is placed in the engine-room. The cold brine is then circulated through the cold rooms—viz., the meat room and the vegetable room—and also through the coils in an ice-making tank placed in the vegetable room. This arrangement has been adopted so that no ammonia can escape by any possible means into the cold rooms. The piping in the cold rooms consists of galvanised coils placed as close together as possible, through which the brine passes, and is circulated by means of a horizontal duplex pump. On the discharge side of this pump there are three regulating valves for regulating the flow of brine to, and to control the temperature in, the meat room, the vegetable room, and the ice box. The engine and compressor, as seen from Fig. 51, are of the vertical type, and are mounted on one base plate, making the plant entirely self-contained. The compressor is single-acting, as this renders the plant much easier to handle, and less liable to leakage. The coils, tank, refrigerator, and condenser are all galvanised, as are also the brine pipes. The ammonia fittings and valves are of the Pulsometer Engineering Company's forged steel pattern, cut from the solid. A special arrangement is provided whereby the ammonia can be purified, and all oil, &c., extracted from the machine. A vertical reciprocating pump of the "Karoome" type, as made by this firm, is shown in Fig. 50. It is used for circulating the water, and is placed in the engine-room.

The refrigerating machinery and arrangements of the Liverpool Refrigeration Company, Limited, are of their kind thoroughly up to date; and although we are debarred from giving illustrations and particulars of the machinery now being fitted by the company to the Cunard turbine steamers Lusitania and Mauretania—which has been specially designed and is electrically driven—Fig. 52 illustrates one of the company's latest compound duplex $CO_2$ machines, as fitted this year on the Cundard steamers Slavonia and Pannonia, on the new Booth Line steamers Lanfranc and Antony, and last autumn on the American Line steamers New York, Philadelphia, St. Louis, and St. Paul, and the Canadian Pacific steamship Monmouth, and others. These machines, it may be stated, are also typical of those fitted on the Cunard Liners Mauretania and Lusitania for the ship's provision plant.

While having a large general experience in refrigerating business, the Liverpool Refrigeration Company, Limited, has been specially interested in the carriage of chilled and frozen meats, dairy produce, &c., from North America, and also in the carriage of chilled and frozen meat, and to a more limited extent of various fruits from South America. Of the carriage of chilled beef particularly the company has made a study, this, perhaps, being the most difficult cargo to carry successfully—especially across the tropics—the slightest variation in temperature up or down being fatal to good results. From a list of imports of refrigerated produce we have examined giving the figures for last year we have realised the very large extent of the chilled beef trade. Practically the whole of the imports from the United States are chilled produce, not frozen, and this also applies to a large proportion of the imported produce from Argentina.

Fig. 53 illustrates one of the machines fitted on board the Cunard turbine liner Carmania, and Fig. 54 represents a general plan of the machine room on the same vessel. The following notes descriptive of the arrangement of the plant are not only applicable to the Carmania, but to several other vessels of the same line, and to a greater or less extent to a large number of plants fitted on various steamers largely engaged either in the North Atlantic or South American trade. The plant described is in many respects different from the ordinary type of plant, being specially designed to suit the trade conditions, in which a number of independent shippers have a variety of goods, each requiring temperatures and conditions which it would be in the ordinary way impracticable to provide by means of a single large machine.

The refrigerating plant on Cunard steamer Carmania—also applicable to the following steamers of the same line:—Caronia, Carpathia, Ivernia, and Saxonia—is arranged primarily for the carriage of chilled beef, and is also designed for the carriage of dairy produce, fruit, bacon, &c., as well as frozen meats. A complete and independent plant is also provided for the preservation of the ship's provisions. The plan—Fig. 54—gives the general arrangement of the machine room, in which are placed not only the cargo machinery, but also that for the ship's provisions. The machinery is on the ammonia compression system, and the cold chambers are all cooled by means of galvanised wrought iron piping specially arranged in them. The provision plant consists of a single steam-driven machine, with gas condenser in the box-bed underneath, an evaporator, and a brine pump, the cold parts being enclosed in a small insulated house, as shown. Connection is also made with the cargo machinery, so that any one of these machines can work the ship's provisions if required.

The cargo plant is in six units, any or all of which can be worked together or independently as required. Three compound duplex machines each has a pair of compound steam cylinders, driving from its tail rods two gas compressors. Two independent gas condensers are arranged in the box-bed under the machine. The crank shaft is in two portions, and runs in four bearings, the coupling being in the middle. A neat system of pipes and valves is provided, so that by taking out the coupling bolts, each side of the machine can run quite independently of the other. Further, either compressor can deliver into either or both gas condensers; in short, the machine is the full equivalent of two independent machines combined on one base, and arranged so as to work interchangeably.

The evaporators are independent, six in number, two for each machine, and are arranged in an insulated house partitioned off from the machine room. They are of the vertical circular type, consisting of wrought steel shells, containing circular coils of iron piping, and galvanised. All headers, valves, and connections are of steel. Cross connections are arranged between each pair of evaporators for interchangeable working.

The brine pumps, six in number, are of the horizontal duplex type. They are arranged so that the cold ends are inside the insulated chamber, and are provided with valves and connections for interchangeable working. The cold chambers are four in number, and occupy the whole of the orlop 'tween decks forward. The larger ones are sub-divided with a central longitudinal insulated bulkhead. The chambers are fitted with a complete system of galvanised wrought iron brine piping, specially arranged to suit North Atlantic work. Each chamber is quite independent of the others, and can be supplied with cold brine at any desired temperature. The whole of the chambers are fitted with rails and hooks for hanging chilled beef.

The distinctive features of these and other similar plants are—the large number of units which can be worked independently or combined in any necessary degree, as desired. The various classes of goods carried, and the number of shippers using these chambers, render this arrangement a very desirable one. Each shipper can have his own chamber worked by an independent machine, and supplied with brine at any desired temperature, without any reference whatever to the other cold chambers in the ship. Great attention is paid to accuracy of temperature, the chambers usually varying not more than a fraction of a deg. Fah. during the voyage. For chilled meat especially this is absolutely necessary, in order that consignments may be landed in the best condition. The brine temperature must be maintained steadily, and within a very few degrees of the temperature of the chamber itself, consequently a much larger pipe-cooling surface is provided than is usual for the carriage of ordinary frozen goods, and the disposition of this surface in the best way requires no little experience and skill. The tendency in these days to cheapness is to cut

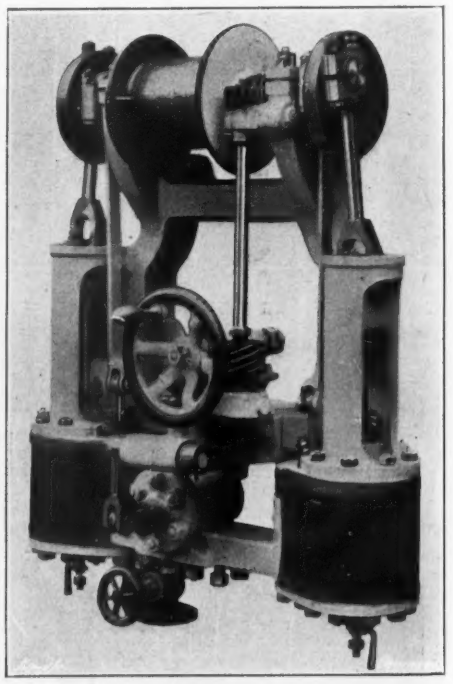

Fig. 45—ASH HOIST—ALLEY & MACLELLAN

the pipe surface down to the lowest possible point, but much better results would be obtained by having larger surfaces less intensely cold.

The brine distribution of the s.s. Carmania is entirely closed. The usual system is to carry the returning brine pipes to an open tank, from which the brine pump draws its supply, pumping it through the evaporator, and thence to the headers supplying the various rooms.

With the entirely closed system there are no brine tanks beyond a small one for mixing brine in the first instance for charging into the system. The return brine pipes lead to a closed header with regulating valves and thermometers, one for each pipe section. The brine collects in the header, and passes through to the evaporator, from whence it is drawn by the pump. The regulation is effected by thermometer only. This can be done quite as accurately, and as easily, as when the actual flow through the pipes can be seen. This system is in use in many vessels, from the largest down-

wards, and in the case of the s.s. Carmania there are thirty or forty sections, all controlled in this manner. Any little air or gas which can possibly accumulate in the pipes is automatically trapped off by a special vent pipe carried from the top of the evaporator.

A glance at the plan of the engine-room will show all the cold parts of the plant enclosed in an insulated chamber. No cold parts are individually lagged, but are protected from heat by being placed in the insulated chamber, while at the same time all are thoroughly accessible for examination, cleaning, or painting without the necessity of removing any lagging or covering whatever.

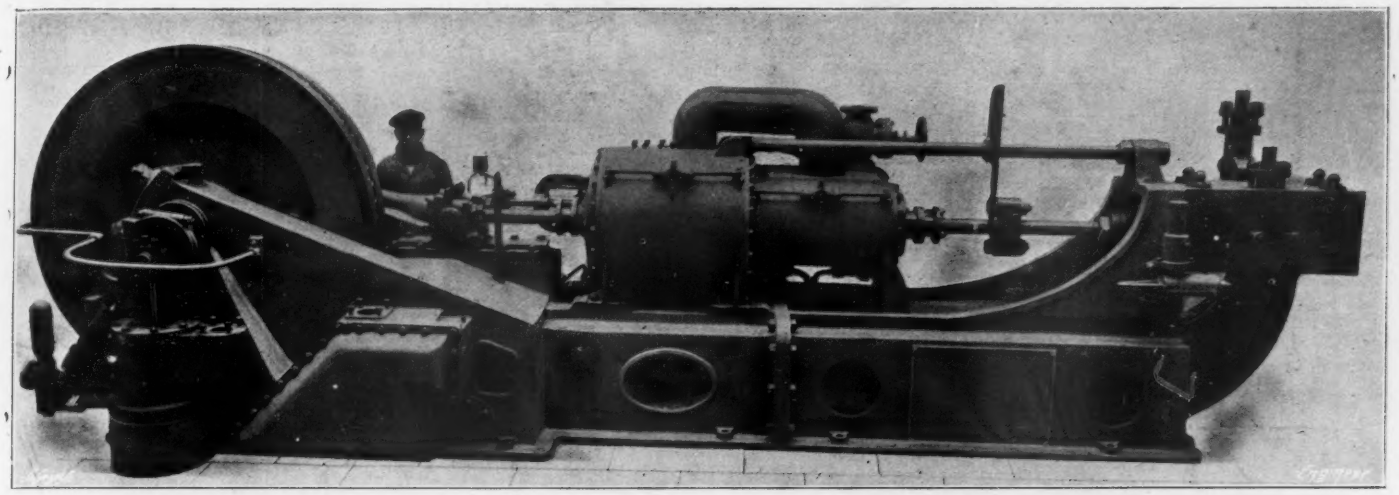

Fig. 46—SINGLE COMPRESSOR REFRIGERATING MACHINE, S.S. LA BLANCA—J. & E. HALL

The plant above described is typical of a large number fitted on many steamers of the leading North Atlantic lines, all of which are arranged upon the same system, and several of which have been in successful operation for years past.

In the South American trade, the successful carriage of chilled beef on voyages of thirty-five to forty-five days and across the tropics, may be counted among the greater successes of the application of refrigerating machinery, and there is no doubt that, with proper care, efficient plant, and handling, chilled meat can be brought from New Zealand or Australia just as successfully as from the Argentine. The general principles of extreme accuracy of temperature maintained with [illegible] variation in all parts of the cold chambers, together with proper precautions in the chilling and handling of the meat before shipping, are vital to success, and the longer the voyage the greater the care necessary.

## SECTION V.—DECK MACHINERY.

While the hopes and aims of the marine engineer and shipbuilder have been largely centred of recent years in the increased speed of ships—consistent with reasonable economy—through the application of the steam turbine, not only in high-speed passenger and mail steamers, in which economy of fuel consumption is less a consideration, but in moderate-paced cargo-carrying vessels, the aims and efforts of the thoughtful shipowner and ingenious shipbuilder have at the same time been keenly concentrated on the problem of ship design and equipment, having celerity of loading and discharging of cargo as the end in view. This disposition of thought and effort has brought about a very striking metamorphosis in the conventional cargo-carrying class of ship as regards cargo holds and the equipment for cargo working. Masts, from being staunch and graceful factors in the propulsion of ships, have dwindled and thinned down into mere flag poles, or have dwindled and thickened into the more utilitarian centre posts for derricks. Now, the latest phase of the change on board many vessels is the uncompromisingly upright and staunch centre posts for cargo derricks, grouped, two abreast about the cargo hatches, all with their array of cargo-gripping tentacles, ready and obedient to the impulse and demands of the steam, hydraulic, or electrical engines placed at their base. Allied with such efficient means of handling the preponderating freight elements obtainable—which in this country consist of coal outwards and ore homewards—and with the resulting celerity in cargo working and quick despatch from ports, even the ocean-going mercantile "tramp" steamer may soon aspire to rank with the most up-to-date turbiner. It may be hoped, indeed, that ere long means will be found to assimilate the turbine principle of propulsion to the requirements of the rank and file of "seeking" boats. At all events, should the present type of reciprocating engine be retained for any indefinite period for propelling mercantile tramp or "seeking" tonnage, a vastly greater return to the shipowner may be obtained from a ship equipped with electrical facilities for rapidly and economically handling the homogeneous bulk cargoes referred to, while a considerable saving by the same means may be effected in handling miscellaneous package goods.

Designs, for example, have been shown us wherein by the adoption of electricity as the prime mover for economically handling cargo instead of the conventional steam winch, greatly enhanced despatch is assured at ports or roadways—and even in circumstances where the usual shore facilities are either already fully occupied or non-existent. In one of the designs referred to, in place of the usual steam winches and derricks, there was erected a complete system of electric cranes fixed two abreast, and so placed that two pairs could work alternately into one hold, either with a port and starboard delivery, or into a double-tiered warehouse. As this scheme has not yet materialised details need not be offered, beyond saying that each crane had three motors, one each for hoisting, derricking, and slueing, of powers 90, 26, and 12 brake horse-power respectively, each crane being designed for a working load of 5 tons. The *raison d'être* of the design referred to, and of the electrical features of the vessel embodying it, is to secure the carrying capabilities and the loading and unloading expedition which now appertain to the representative modern grain, ore, or coal "freighter" on the Great Lakes of America. The special plant for handling coal and ore at the main ports on the Lakes is a feature of the ports themselves. The plant is stationed on *terra firma*, and forms the natural concomitant of development where these materials are solely or chiefly concerned. In Europe and Asia, on the other hand, ports and harbours have grown and developed in ways consonant with the needs of widely varied materials. The provision of suitable plant on *terra firma*, therefore, either does not exist, or only so in very inadequate measure. The main distinguishing feature of the design in mind is the carrying by the vessel herself of all the desired equipment for efficiently loading and unloading bulk cargoes, however meagre or inefficient the plant on shore may be. Associated with the electric deck cranes are grab buckets, and, of course, an arrangement of hatches and holds designed to contribute to the full utilisation of the mobility and power of such appliances.

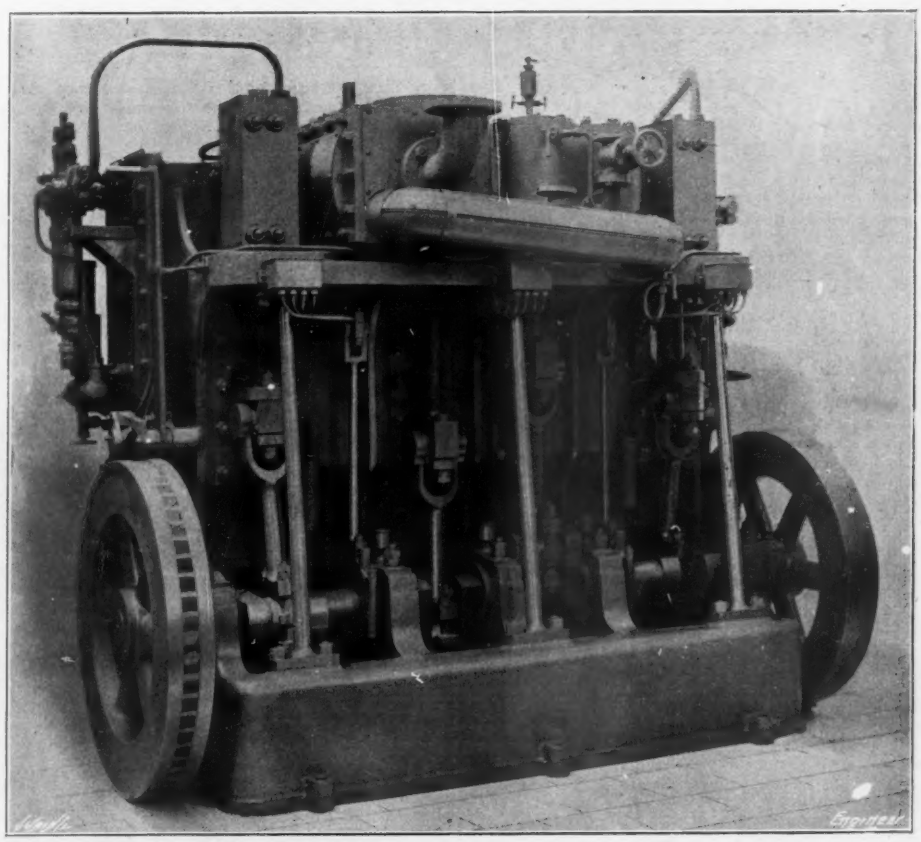

Fig. 47—DUPLEX REFRIGERATING MACHINE—J. & E. HALL

Electricity, as concerned with deck machinery less conspicuous but greatly more vital than cargo working gear—viz., steering engines and gear and anchor working appliances—is most certainly gaining a footing. It will doubtless rapidly develop when experience promotes confidence in the reliability of electric power applications under all ordinary emergencies. Just as was true in the case of artificially lighting a ship by electricity, so it may be years before the amount of confidence in power applications will be such as to justify entirely dispensing with older and better tried means. However this may be, it cannot be gainsaid that, apart from natural conservatism and intervening practical obstacles, there is *primâ facie* a convincing case for the introduction of the newer power for most purposes, especially on board ships in which electricity is generated and used, partially for power purposes as well as for lighting.

Electricity applied to ships' auxiliary machinery has distinct advantage over steam by reason of its flexibility. No long lengths of steam piping, with its inherent drawbacks, are required. Motors can be placed in positions almost inaccessible for a set of engines. The comparative silence of the gear, simplicity of operation, as well as the quick speed attainable, make the question of electric power for auxiliary machinery of first importance. The feature of electrical driving is economy of working, and there is no better example of this than hoisting machinery, where the speed automatically varies with the load, and the current consumed is proportional to the work done. Electricity, from its very nature, fulfils the requirements of deck machinery, and the developments in this line are illustrated in the accompanying figures, which represent some of the most modern types of winches and cranes for ship's use. First and briefly, however, reference may perhaps usefully be made to the association of electricity with

engines and gear in which steam is still the motive power employed. One such application is an electrical control gear combined with the ordinary steam steering engine, which has been applied to several well-known vessels of late by Siemens, Bros. and Co., Limited, of Westminster,

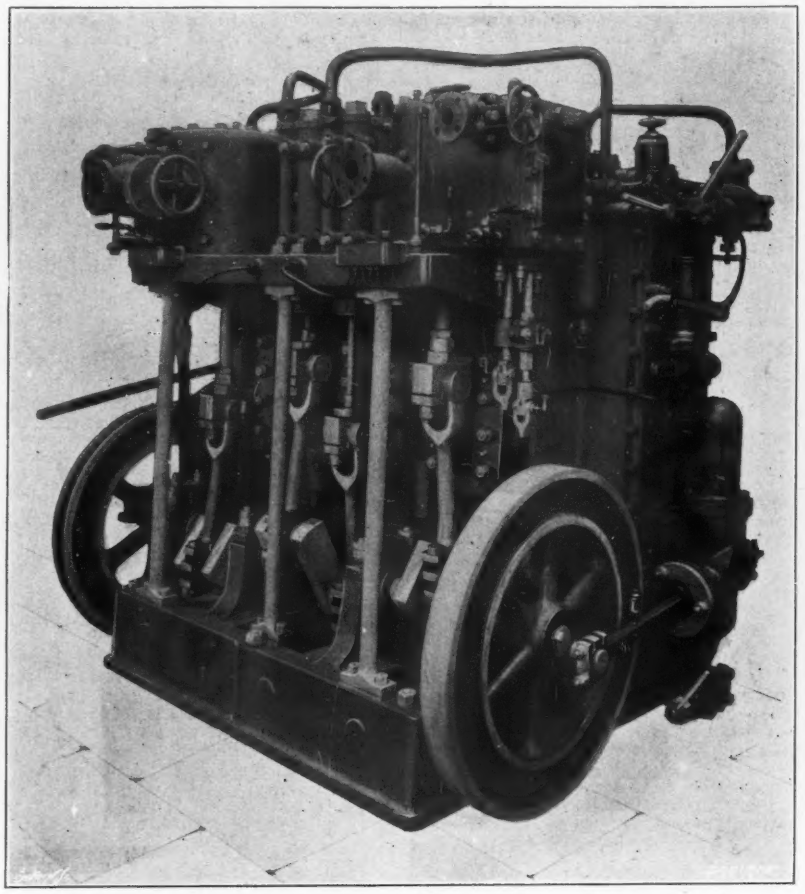

Fig. 48—REFRIGERATING MACHINERY, S.S. VICTORIAN AND VIRQINIAN—HASLAM

which does away with shafting entirely, and substitutes for this too often troublesome and wasteful detail a flexible cable, easily installed, and having all the advantages a cable possesses of freedom from excessive wear and breakdowns. The steering hand wheel on the bridge operates a vertical shaft which extends to a shunting switch and controlling motor, the placing of these below the deck being intended to obviate any possibility of interference with the compass; a slight turn of the hand wheel and, therefore, of the vertical spindle, causes current to pass to the controlling motor, the working of which causes a disc geared to it to follow another connected to the vertical shaft, and, as long as the steersman turns the hand wheel the two revolve together, the one punting the other, and, immediately the hand wheel is stopped, the current is cut off, stopping the action of the steering gear. The current is passed by the punting switch to the actuating motor, which again sets in motion the main motor through the connections. The contacts are so arranged that the current will go on gradually and the risk of sparking is reduced. The controlling motor re-acts on the punting switch, by means of which the current to itself and to the actuating motor is controlled. Both motors work synchronously, so that they rotate through an arc exactly corresponding to the amount the steering wheel is turned. The details of this promising system of steering engine control we hope to describe and illustrate some time later, when it has more fully declared itself.

Referring to electricity as applied to hauling gear an example of a Clarke, Chapman electric capstan windlass to deal with $1\frac{9}{16}$in. stud link cable is illustrated in Fig. 53. This machine, it will be noted, has two lifters suited to the size of cable mentioned. These lifters are loose on the shaft, and provided with patented direct grip action, thus preventing their movement along the shaft in either direction, unless the hand wheel be turned. A 24 brake horse-power motor is provided for driving the lifter shaft through worm and spur gearing, and a powerful improved screw brake is fitted to each lifter. A warping capstan, it will be noted, is also provided, driven through bevel wheels and a vertical shaft, and gear is fitted enabling the capstan or windlass to be worked by hand or by motor power. The controller and resistances are attached to the windlass bed. These, together with the motor, are completely water-tight, and all cable connections are run in pipes.

Fig. 56 also illustrates an electric anchor and warping capstan of Clarke, Chapman's make, which is arranged to work by motor power or by hand, and is suitable for $\frac{3}{4}$in. cable or for warping purposes. It has a 5 brake horse-power motor driving the capstan barrel. Provision for water-tightness, as concerns the motor controller and resistances, and various cable connections, has been made.

Electric ship's deck baggage winches, electric boat hoists, and electric whips for a variety of purposes, are all articles of manufacture which Clarke, Chapman, and Co. have had to produce of recent years for high-class mail and passenger steamers, in which electricity plays so large a part, and is likely to develop more and more as time goes on. The describing of the auxiliary and appurtenances fitted on board naval ships does not enter into the scope of this Supplement; but with the object of showing that the Gateshead firm brings to bear on its work for merchant steamers extended experience in the manufacture and supply of electrically-driven appliances fitted on naval ships, it may be mentioned that its list of coal hoists, boat hoists, ash hoists, and ammunition hoists is already a very extensive one, and is concerned with the equipment in these directions of at least thirty-six of his Majesty's cruisers and battleships down to the Dreadnought and Agamemnon. As regards merchant vessels, boat-hoisting winches and baggage and mail hoists have been supplied to the Cunard Liners Caronia, Carmania, Pannonia, and Oceana, and to the turbine steamer Maheno, of the Union Steamship Company of New Zealand, Limited, and the Rewa, of the British India Steam Navigation Company, Limited, and a light electric

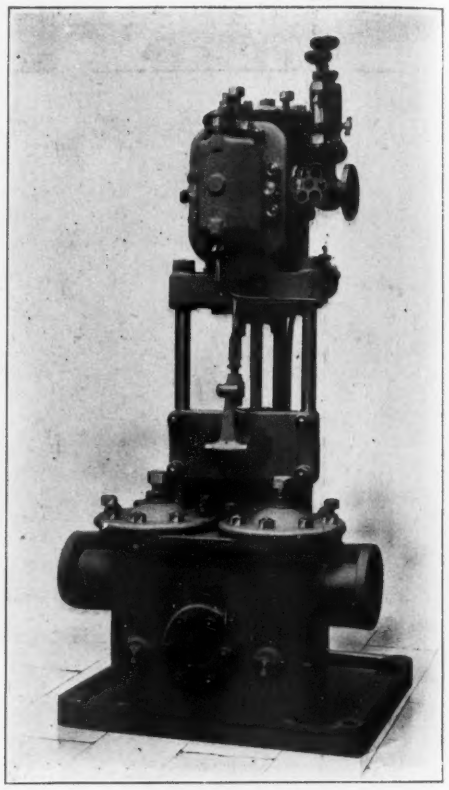

Fig. 50—THE "KAROOME" PUMP

baggage winch by Clarke, Chapman and Co., is shown in Fig. 57.

Figs. 58 and 59 are illustrations of boat and baggage cargo and warping winches respectively, as made by Chambers, Scott and Co., of Motherwell, all electrically driven, designed for the special duty they have to perform, and as used on some of the largest vessels. The winch shown in Fig. 58 represents one of eight winches employed for handling boats on the Cunard turbine liners Lusitania and Mauretania. This winch is compactly built and self-contained, with all the controlling gear encased, only the operating handle being exposed. It is arranged with duplex drums, so that four ropes may be worked simultaneously. The speed at full load is about 200ft. per minute, and is regulated by a starting and reversing

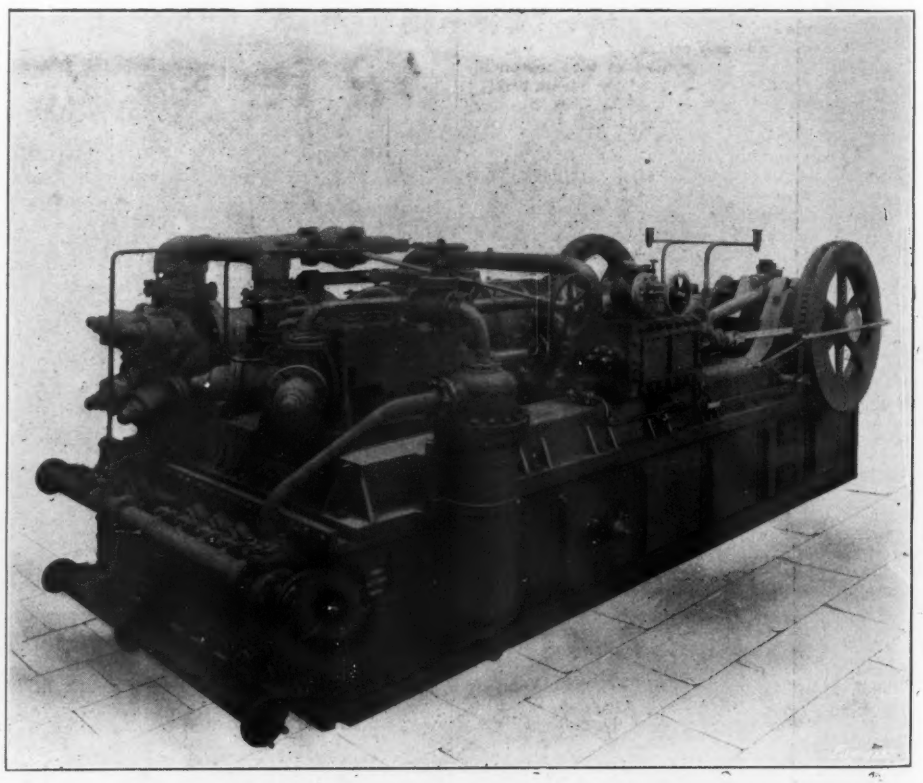

Fig. 49—AMMONIA REFRIGERATING MACHINE—HASLAM

# RECENT TYPES OF REFRIGERATING MACHINERY

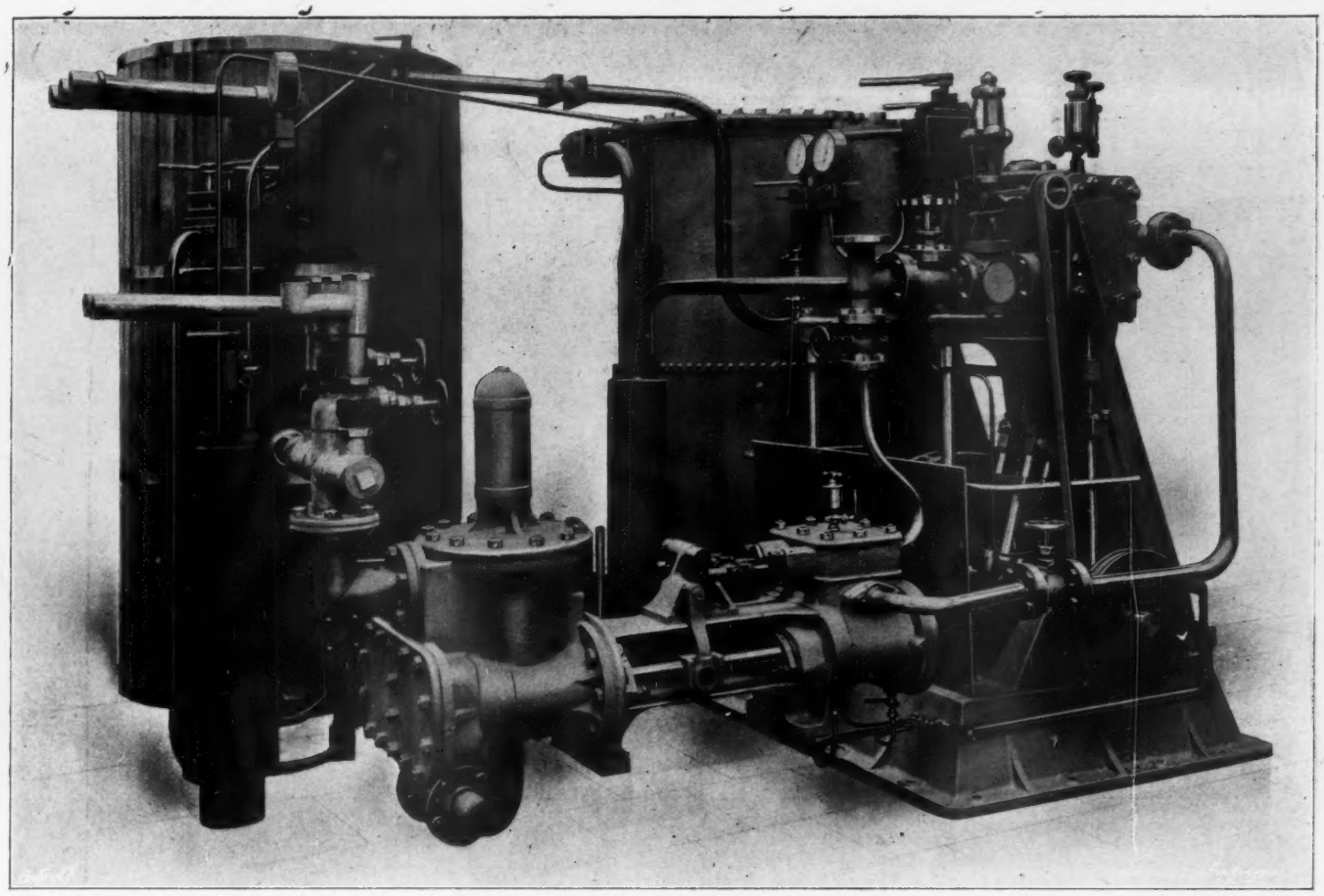

Fig. 51—REFRIGERATING PLANT, S.S. CITY OF LONDON—PULSOMETER ENGINEERING CO.

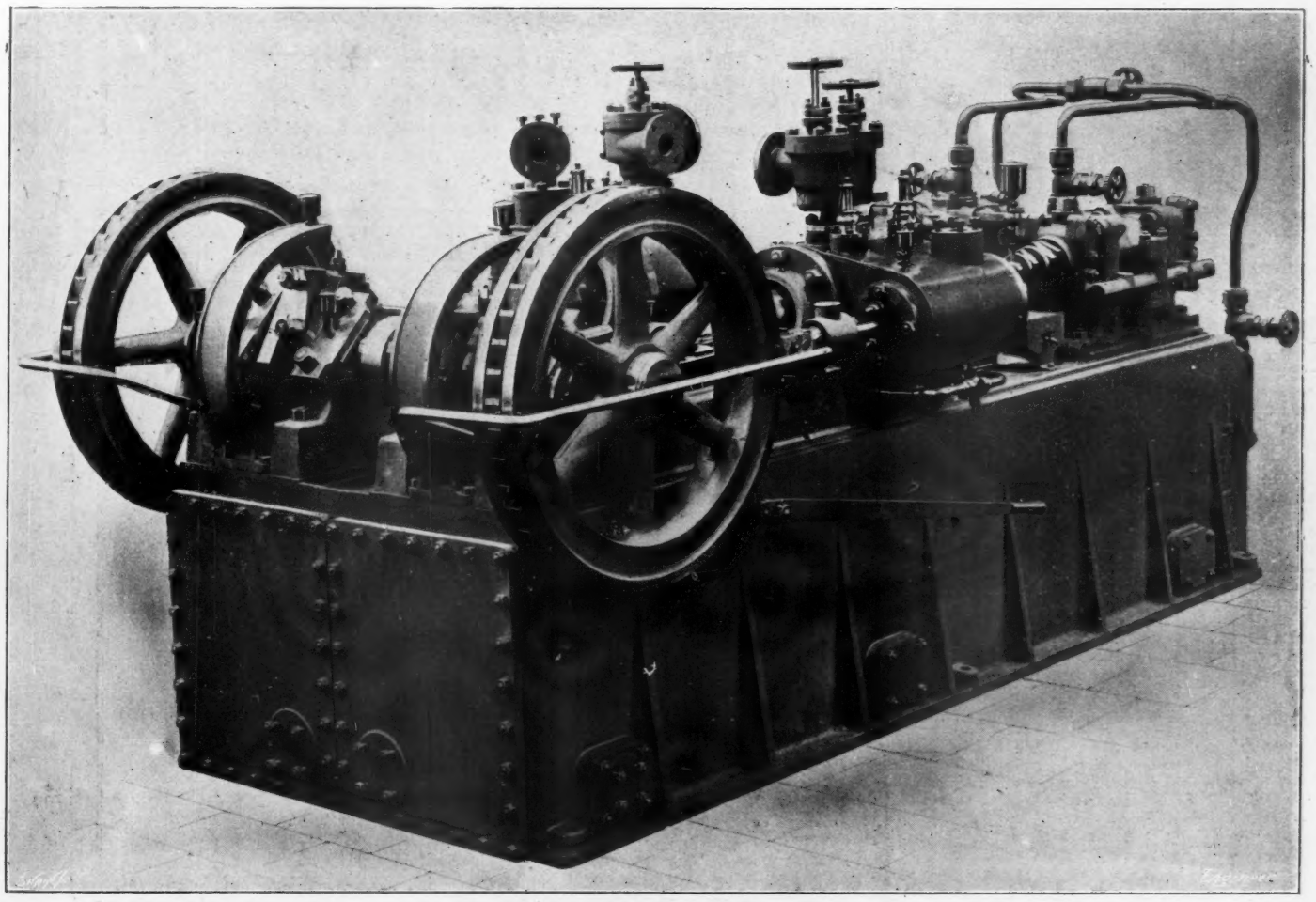

Fig. 52—REFRIGERATING MACHINERY FOR THE SLAVONIA AND PANNONIA—LIVERPOOL REFRIGERATION CO.

controller, giving automatically a series of speeds, whilst the motor is of the variable speed type and fitted with a safety magnetic brake, operated in conjunction with the

sive standards, and driven by worm reduction gear from the motor, the whole being mounted on a sole-plate of strong box section. Machine-faced side doors are provided for

tion, of large capacity for its work, capable of standing heavy overloads, and designed for slow speed, effecting a saving in gear reductions, and ensuring a mini-

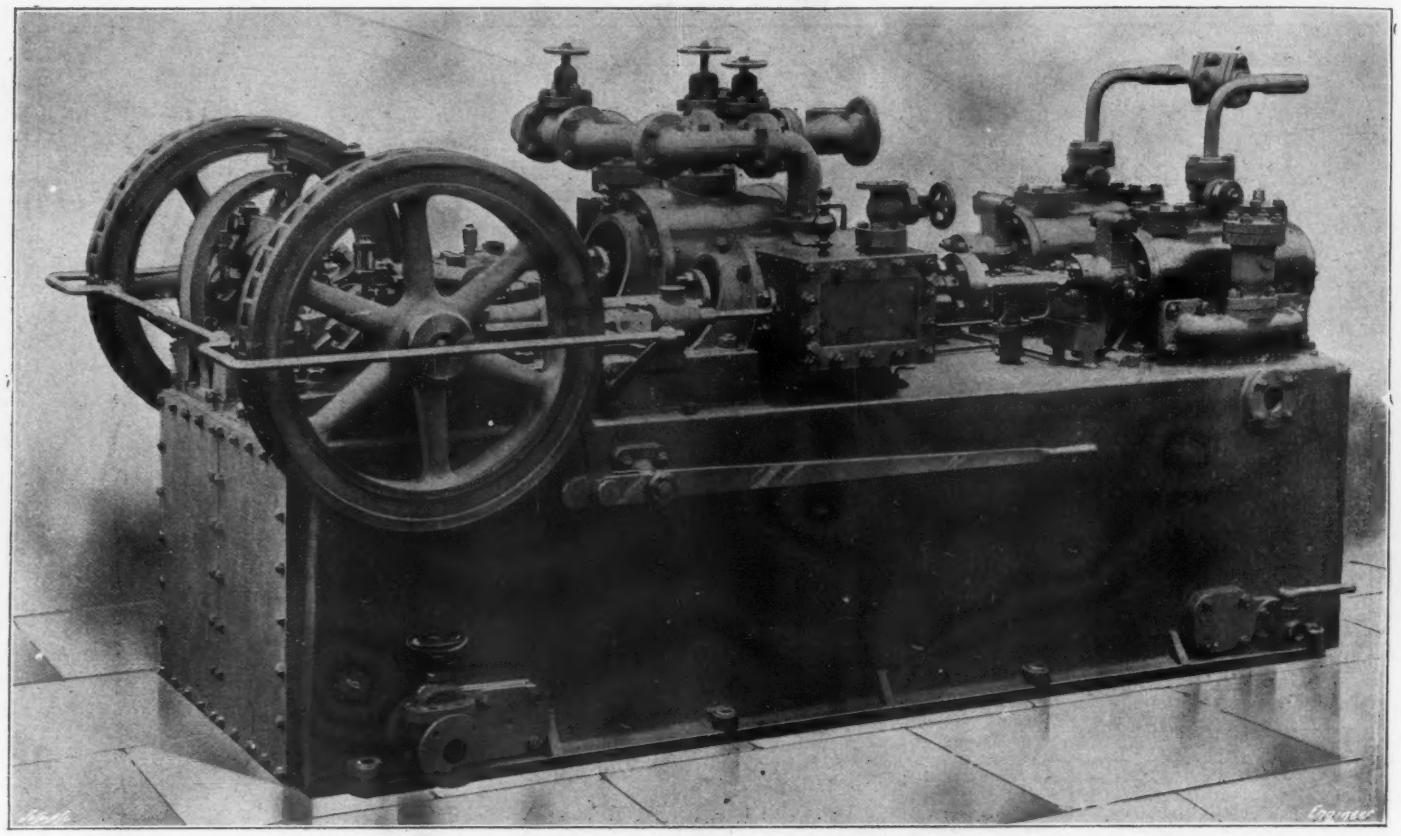

Fig. 53—REFRIGERATING MACHINE FOR THE CARMANIA—LIVERPOOL REFRIGERATION CO

controller, instantly holding the load when the current is switched off or interrupted from any unforeseen cause. The drums are keyed to a steel shaft, carried in two mas-

access, making a thoroughly water-tight casing, the bottom being closed. The motor is totally enclosed and water-tight, reversible, with automatic speed varia-

mum of working parts, and consequently reduced wear and tear. It is operated by a starting, reversing, and speed-regulating controller, placed along with its resist-

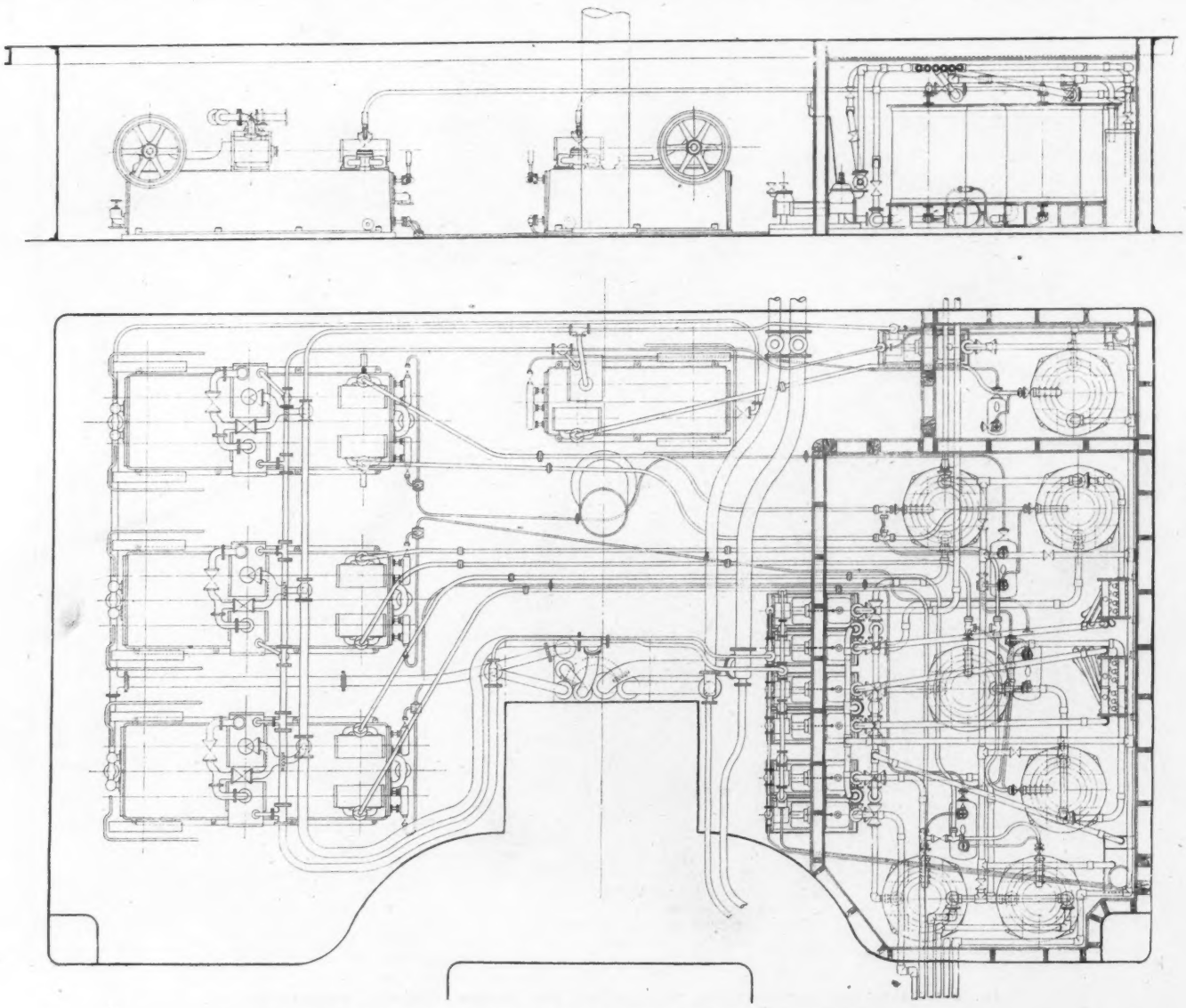

Fig. 54—REFRIGERATING PLANT ON THE CARMANIA—GENERAL ARRANGEMENT

ances, inside the sole-plate. It is actuated by an upright shaft in the pillar mounted on the winch, the handle being removable to prevent interference with the gear. The automatic magnetic brake is of special pattern, no separate coils or magnet being required, and it acts as a speed governor as well as a load brake. Fitted as part of the motor, it is made by Laurence, Scott and Co., Limited, Norwich. It takes up little space, is effective in its action, and provision is made for taking up the wear of the brake shoes. All bearings are bushed with gun-metal, and are adjustable. Automatic lubricators have been fitted throughout, and provision is made for protecting the electric cables from sea water.

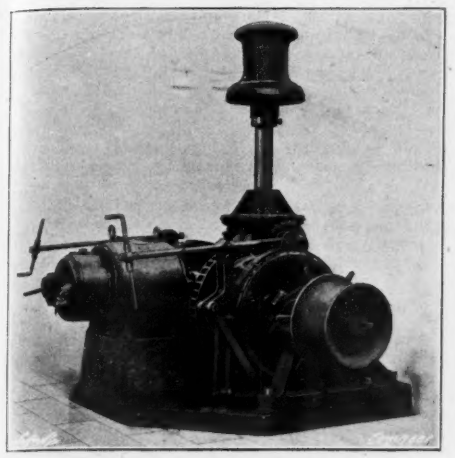

Fig. 55—WINDLASS AND CAPSTAN—Clarke, Chapman

A simple winch to handle baggage is shown in Fig. 59. It consists of two drums driven by worm reduction gearing from a motor, mounted on a combination sole-plate, and equipped with an automatic magnetic brake. In construction it is very similar to the foregoing winch. In this case, however, the controller and resistances are placed below deck in any convenient position, and the operating handle is arranged on a pillar. The winch takes up little space, can be fixed close to its work, whilst one handle controls all the movements, and can be placed in any desired position in the ship.

The two winches above noticed form good examples of electric motors applied to machinery for effecting speed and economy in handling loads, whilst the type of electric winch, Fig. 60, is for cargo purposes, the gear being more silent and efficient, and easier to work than the present steam winch. The arrangement generally resembles existing types of cargo winches, with a centre drum and warping ends. The details of parts and method of working are, however, different. With an electric motor the simplicity of control and the cleanliness of the mechanism contribute greatly to the success of the winch. A box sole-plate carries all the parts, the gear being mounted on two standards, with the motor at the rear, and with provision made for fastening the whole to the deck. The main drum is provided with a clutch and powerful foot treadle brake, so that lowering can be effected very rapidly without current, the warping ends at such an operation remaining stationary. The gearing, motor controlling apparatus and cables are encased in built steel covers for protection from the weather. When used for warping, absolute control is assured by the operating gear and the drums, which are arranged clear of the body of the winch, are braked electrically, and automatically held by the magnetic brake when the controller is in the "off" position.

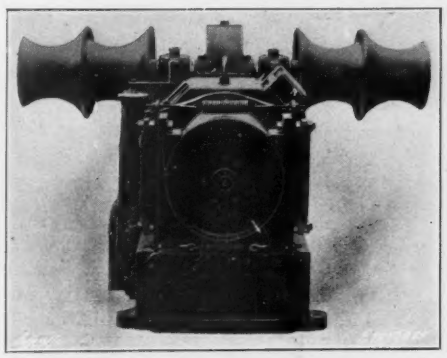

Fig. 58—BOAT WINCH—CHAMBERS, SCOTT

The use of motor-driven cranes on board ship is, as in the case of winches, only of very recent date, but the suitability of electricity is now recognised. Simplicity, economy, cleanliness are all advantages, and are also features in the style of jib cranes shown in Fig. 61 for silent working. Although the usual practice for ship's service is to mount the crane on a post on deck, the adaptability of electric motors permits of greater scope in designing, and in the accompanying illustration, which represents a crane fitted to a small coasting steamer built by the Ailsa Shipbuilding Company similar to cranes now being erected on the steamer Chieftain, the driving gear is placed under deck, and the mast of the crane passes up through a water-tight gland, and carries the jib with its tie rods. Hoisting and slueing is accomplished by levers from a platform attached to a mast above deck, lowering being effected by foot brake or by current, all under easy control. The structure is built of steel, specially arranged to exclude water, and can swing a complete circle, being pivoted on a sole-plate, and fitted with a race wheel for slueing, whilst a grooved drum brake is provided for the load rope, and the two motions are driven by clutches from a friction shaft gearing with an enclosed motor equipped with a safety self-acting magnetic brake. Suitable collectors transmit current to the motor from the main leads from the engine room, and starting, reversing, and regulation of the gear is accomplished by a drum controller fitted in a water-tight case, and mounted conveniently on the driver's platform. The motor is of large capacity for its work, capable of standing arduous duty and heavy overloads, and arranged for slow speed, reversing, with automatic speed variation. The motions can be operated simultaneously or individually by the clutch levers, and also by the use of the controller; but there is no danger of reversing the motor suddenly, as the magnetic brake works automatically with the controller, bringing all the gear to rest in the off position. The crane gear is self-locking, and swinging is prevented without resort to lashing.

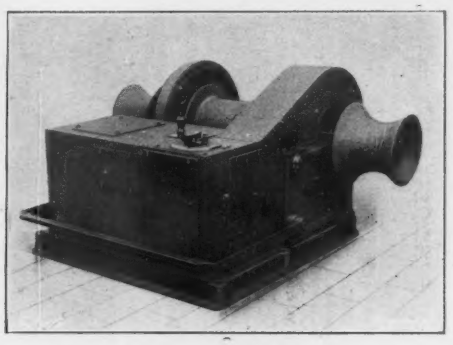

Fig. 60—CARGO WINCH—CHAMBERS, SCOTT

We have received from Mr. W. Stamm, of 25, College-hill, Cannon-street, who is agent in this country for Herr Fried Krupp, particulars of some electrically driven cranes which have been fitted to the North German Lloyd steamers. The information is interesting, inasmuch as it enables one to follow the lines upon which German practice is developing.

These cranes are similar in design and working to the harbour crane type. In order not to load the deck unnecessarily, special care has been taken to reduce the crank weight as much as practicable, All parts are made of material carefully selected for the purpose, so as to possess the greatest strength. The foundation plates of the cranes are screwed on to girders under the deck. The revolving part which swings round a hollow centre pillar forms at the bottom a platform, and at the upper end a casing for the winch. This casing also serves as a protecting hood for the centre pillar, the ring sliding contact provided there, and the electric wires. The electric cables

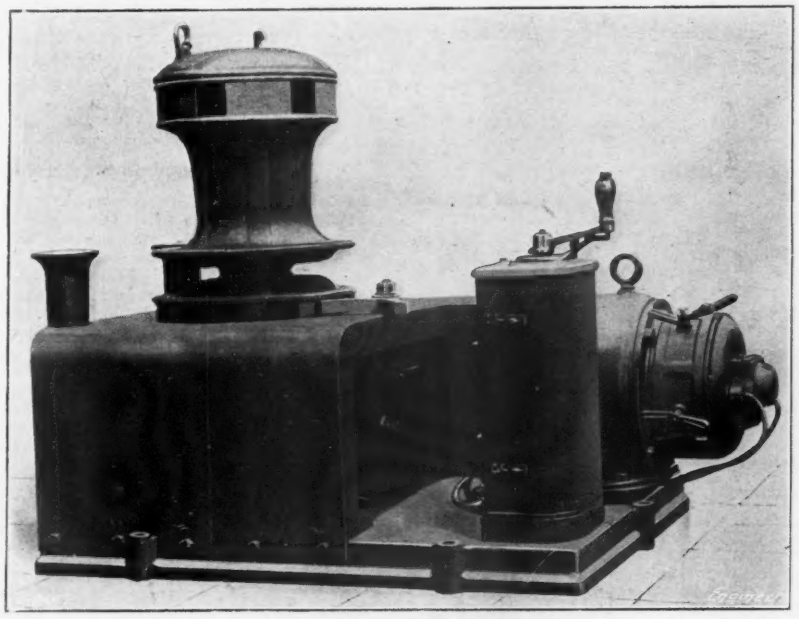

Fig. 56—ANCHOR CAPSTAN WINCH—CLARKE, CHAPMAN

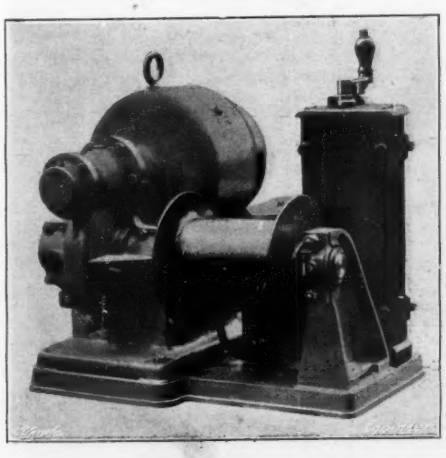

Fig. 57—BAGGAGE WINCH—CLARKE, CHAPMAN

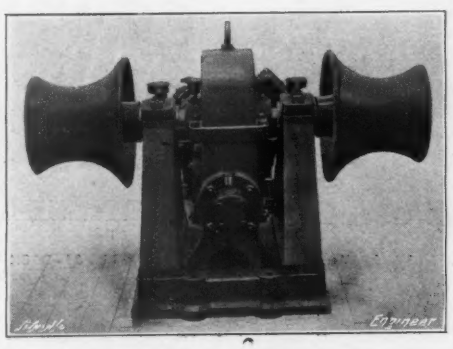

Fig. 59—BAGGAGE WINCH—CHAMBERS, SCOTT

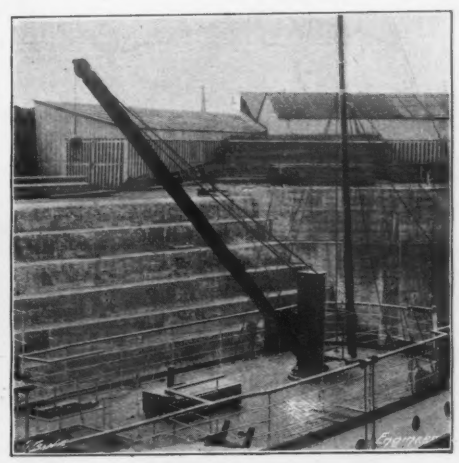

Fig. 61—ELECTRIC CRANE—CHAMBERS, SCOTT

pass from below through the centre pillar. The lifting gear is arranged at the front of the platform, whereas the slueing gear is placed at the back. The lifting gear is worked by an electro-motor geared to the barrel. The barrel has grooves properly turned in it so as to suit the round lifting rope, which is made of the best patented crucible cast steel wire, possessing great flexibility, and

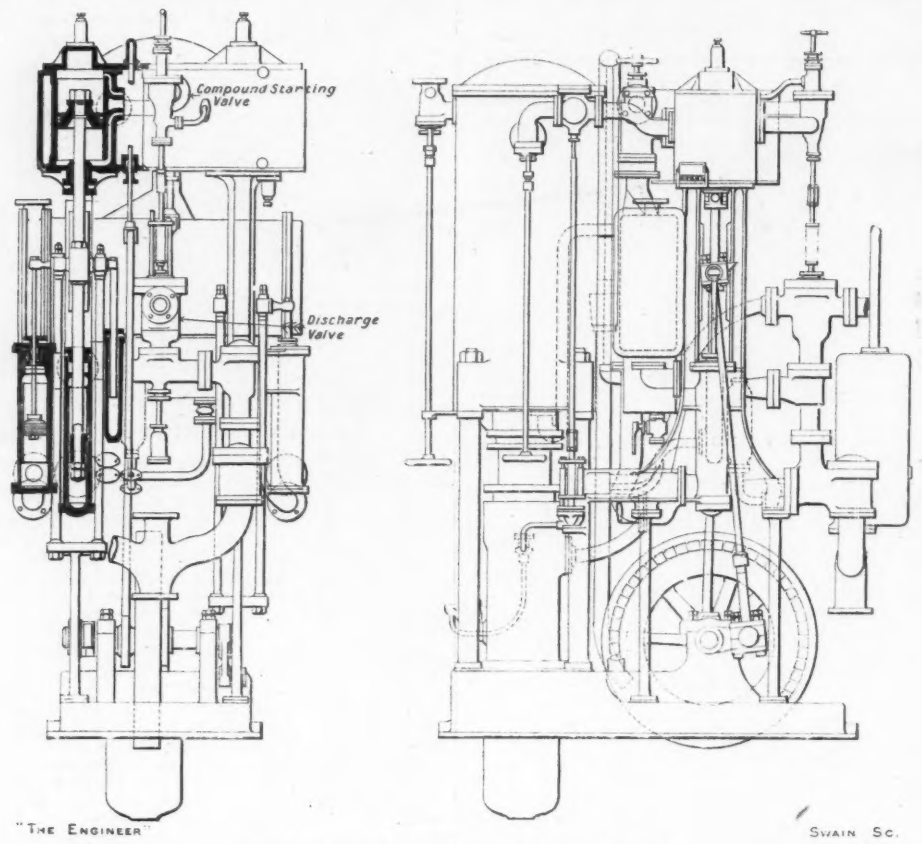


Fig. 62—PUMPING ENGINES—BROWN BROTHERS & CO

tenacity. The lifting gear is also equipped with a warping—capstan—drum. The jib can be lowered by means of the lifting gear, and is removed when the ship is under way.

The slueing motor actuates, through a worm and wheel running in an oil bath, a vertical shaft provided at its lower end with a pinion, which is geared to a rack fixed in the bed-plate. Immediately the current is cut off from the motor a brake fixed on the worm shaft comes into play to stop the motion as quickly as possible. The operation of the motors is effected by two controllers, which are so arranged that the driver can well survey all the motions of the crane. All parts are protected against sea-water and dust. The lifting power of the deck cranes is 1½ to 3 tons, and the radius 4·6 m. (15ft. 1in.) to 5·5 m. (18ft. 1in.). The following gives the speed of the motors:—(1) 1½-ton crane of 5·5 m. radius; speed of lift, 36 m. (118ft.) per minute; speed of slueing, 100 m. (328ft.) per minute, measured at jib-head; (2) 3-ton crane of 5·5 m. radius; speed of lift, 20 m. (66ft.) per minute; speed of slueing, 90 m. (295ft.) per minute at the jib-head. These speeds may be still increased; they depend on the kind of motor employed. The worm wheels are made of phosphor bronze, or gun-metal, and are enclosed with their steel worms in tight casings. The bearings of the worms have ring lubrication; the side pressure is checked by ball pressings. The hook is also provided with ball bearings in order to avoid whirling motions of the load due to untwisting the wire rope. All parts are easily accessible, and it is said that the cranes require but little attention.

Apart, perhaps, from the portion of the hydraulic plants on board ship concerned with steering the vessel, the cranes and hoists for cargo working are of most interest and importance. The ordinary post cranes which are generally supplied by Brown Brothers, of Edinburgh, are of the type introduced by the late Mr. A. B. Brown. They have been improved in detail, but, as made by themselves and others, are not very dissimilar to the original design. Fig. 63 and Fig. 64 are examples of cranes fitted to recent British India steamers by Fullerton, Hodgart and Barclay, Paisley, whose make of vertical triple-expansion hydraulic pumping engine fitted to the same steamers is illustrated in Figs. 67 and 70 on pages 19 and 20. An example of a hydraulic crane having special features as fitted by the same firm on the paddle "sponson," of the steamer Viena, which was built by A. and J. Inglis for service on the River Plate, is illustrated in Fig. 66. A special arrangement of hoists by Brown Bros. and Company for working in connection with ordinary ship derricks is illustrated by Figs. 68 and 69. This is found to be a very quick and efficient method for working cargo, and has been very largely adopted by one of the leading lines of steamships trading in the East to meet the special requirements of the service. The cargo is lifted from the hold by one hoist and then transferred to the other, the derricks being adjusted to suit this. When taking in cargo the process is reversed as between the two hoists and ship's derricks engaged.

While expedition is not the outstanding advantage of cargo working gear on the hydraulic principle, this quality

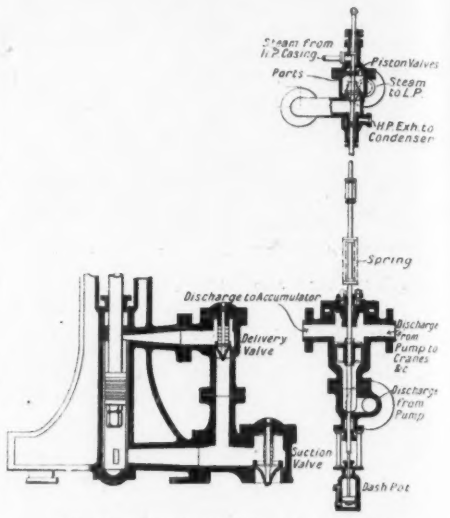


Fig. 65—PUMPING ENGINE VALVES—BROWN

is yet possessed by the system, and economy of working in all cases, together with reliability and handiness in cases where hydraulic gear is fitted to vessels doing service in warm and equable climates, are considerations which weigh with many shipowners in adopting the system. The great virtue of silent working is, of course a powerful inducement to the adoption of the system in passenger carrying vessels, and companies whose vessels are engaged in the East, and others having large fleets in South American waters, have for many years fitted, and more and more continue to fit, hydraulic gear for both steering purposes and cargo working. Besides silent working, the speed is equal to, and in most cases faster, than the system of steam winches, while the coal consumption with the hydraulic system is said to be less. Unless in the case of special services, as has been indicated, however, the greater initial cost, and the risk of difficulties with freezing, are points against the adoption of hydraulic pumps and deck gear,

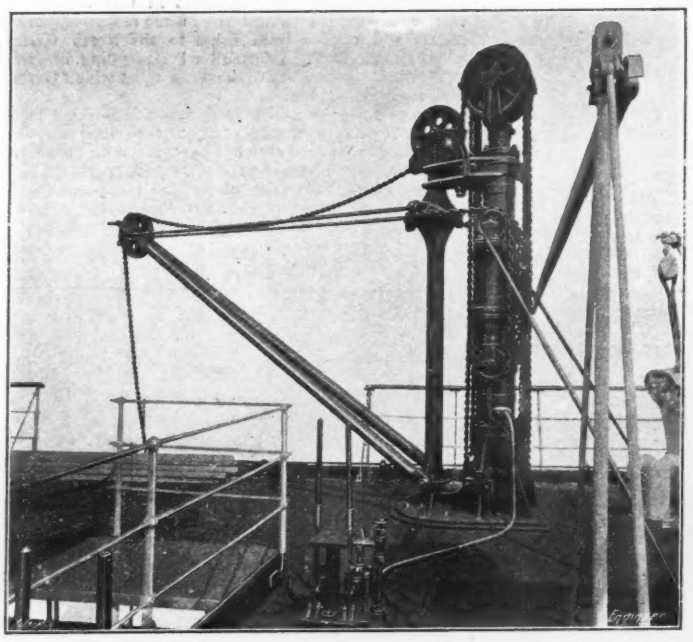

Fig. 63—HYDRAULIC CRANE—FULLERTON, HODGART, & BARCLAY

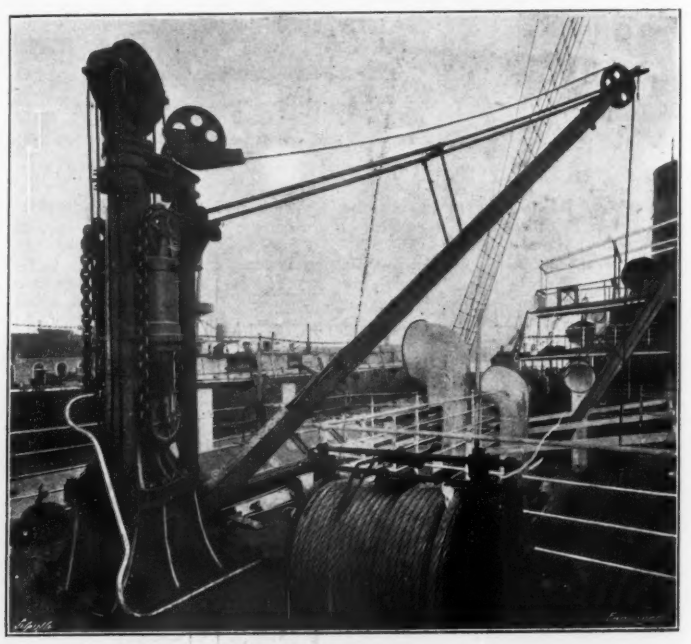

Fig. 64—DECK CRANE—FULLERTON, HODGART, & BARCLAY

But, as has been said, a largely increasing number of hydraulic cargo discharging plants is being made, not only by the original introducers of this system—Brown Brothers and Co., Limited, Rosebank Ironworks, Edinburgh—but by other firms on the Clyde and elsewhere. The pumping engines by Brown Brothers and Co., whether of the two-crank type with differential gear, as shown in Fig. 62, or of the three-crank type with ordinary plungers, have been recently re-designed and brought up to date. The example shown has steam cylinders 11¼in. and 20in. by

18in. stroke; the accumulator steam cylinder being 27in. diameter by 5ft. 1in. stroke. The engines are all automatic compound, arranged on the system patented and worked out by the founder of this firm, the late Mr. A. Betts Brown. They are either fitted with their own condenser and pumps arranged to exhaust into an auxiliary condenser or waste steam pipe. These pumping engines show a great economy in steam over non-compound. They have also been made on the triple-expansion principle, but have not been largely adopted, owing to—in Brown Brothers' experience—their not responding to sudden changes of load and to the large size of the intermediate-pressure cylinder required, seeing that live steam must be admitted for starting on certain occasions. The details of the valves for the pumping engine illustrated in Fig. 60 are shown in Fig. 65.

Owing to the exigencies of space we cannot deal with steering gears so fully as such an important item in the equipment of a ship deserves.

In fitting steam steering gears to steamships, especially of the larger dimensions now common, it is the most approved practice to place the steering engine directly attached to the rudder-head, thus dispensing with chains or wire ropes leading from the rudder-head to the steering engine amidships. This arrangement obviates the danger connected with the breaking of such chains or ropes, and also the objectionable noise accompanying their working. With the present day large steamers there is always a considerable distance between the steering engine itself and the position from which it is controlled. It thus becomes necessary to have some means of communication between the steering engine valve and the steering wheel on the bridge, which latter is situated in many cases very near the bow of the ship. This is usually carried out by a line of shafting, running in a great number of bearings, and requiring bevel

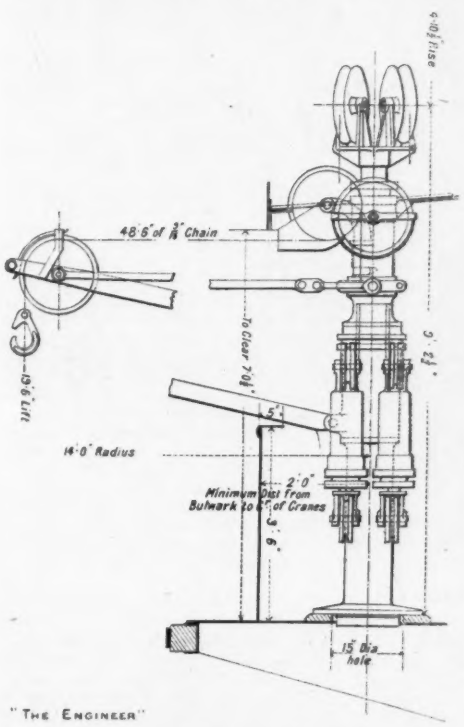


Fig. 66—HYDRAULIC SPONSON CRANE

wheels, or Hooke's joints, when the shafting deviates from the straight line. In most ships, and particularly in long ships, the friction of this gearing is very considerable, and the steering wheel is consequently very stiff to work. Attention is also required in oiling the various parts, and unless the shafting is heavy there is a considerable spring or twist taking place between the wheel on the bridge and the valve gear aft, which tends to irregular steering, and requires great exertion. An ingenious device for obviating this is Brown's hydraulic telemotor, which supplies a means of communication between the bridge and the steering engine as near frictionless as possible, even though the line of communication be tortuous.

To a large extent, in modern practice, modifications have to be made on steering gears as well as other items of deck machinery, due not only to the increasingly varied conditions of service, but also to the regulating and often inflexible arrangement of the naval architect and shipbuilder imposed upon them from other causes than the point of view of steering gear makers, who, of course, aim at and skilfully strive after efficiency, no matter what the conditions of situation and service may be. This remark is suggested to us from a study of some of the modern steam steering gears as made and supplied in variety as well as number by many well-known firms.

Examples have come under our notice of gears without brake and buffer arrangement, but steered by steam from the bridge with telemotor apparatus and from the after deck by ordinary shafting as a standby, an arrangement, of course, also being made for steering by hand at the engine. An elaborate arrangement of combined steam and hand gear is that fitted in large oil tank steamers and other similar craft by Bow, McLachlan and Co., Limited. In the arrangement referred to the vessel can be steered by four different methods:—(1) By steam from the bridge through bevel gear; (2) by hand at the engine through screw gear; (3) by steam from the bridge through the barrel gear; (4) by hand at the engine through the barrel gear.

In dealing at such great length with the equipment and outfit of mercantile steamers, it is impossible for us, in the space left at our disposal, to make more than a cursory reference to a subject which, if an unpleasant one, is yet ever-present and exceedingly interesting to engineers. We refer to the subject of mishaps and repairs of all kinds. It is obvious that all such repairs must be of a limited character. Of course, many examples evincing mechanical ingenuity and skill will be at once recalled by our readers, but these, after all, were of a purely tentative character, and merely fulfilled their purpose until the ship reached port. But the growing tendency is to place on board our ships tool rooms which vie in equipment with many of the small repairing shops to be found at most of the ports of call of the most important ships. The adaptability and universality of the modern machine tool enables the naval architect to place in a minimum of space appliances which but a few years ago could never have been found outside the land workshops. This has also been greatly facilitated by the increasing use of self-contained electric motors as a means of driving such machine tools. Probably it will in the near future be a subject well worthy of the consideration of steamship owners and designers whether a certain amount of space, presumably abstracted from cargo capacity and devoted to such purposes, does not afford a prospect of more than repaying itself. The many adjustments which the prolonged running of any machinery plant entails, and which must either be carried out by private firms or in shops maintained by the owners on shore, could then be undertaken by the permanent staff.

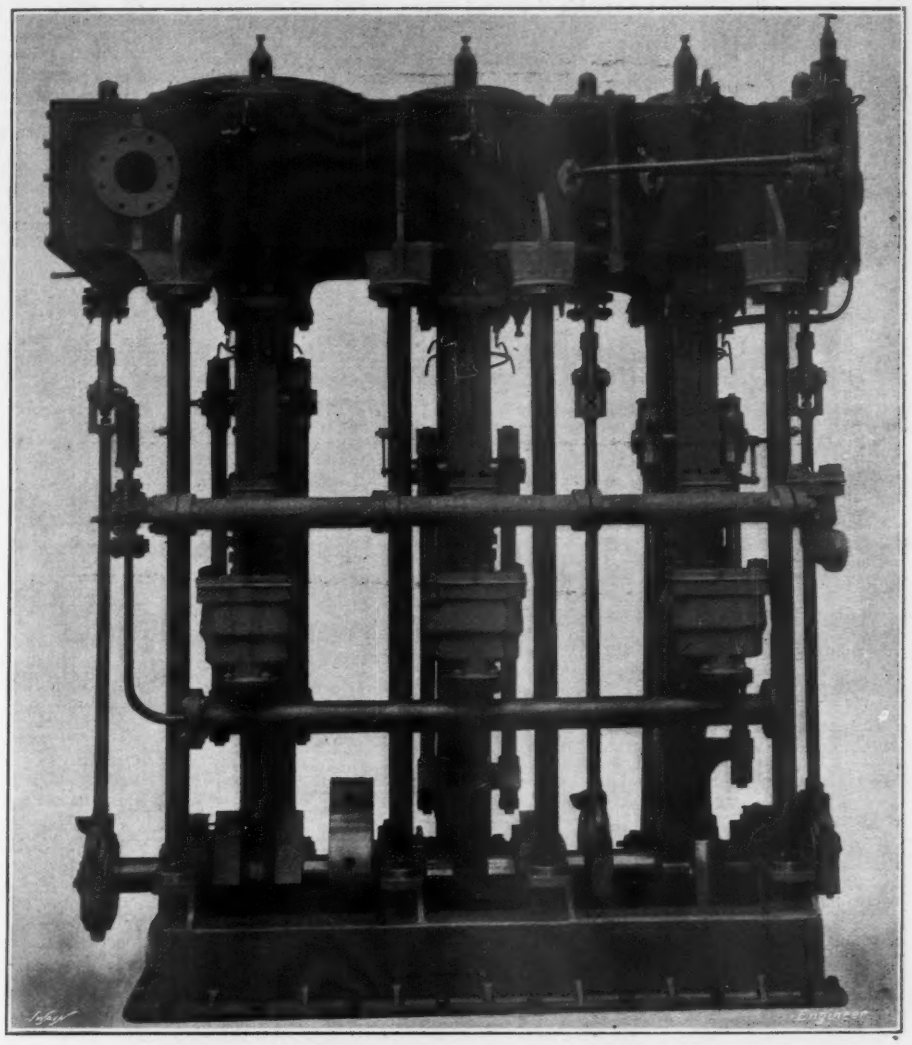

Fig. 67—HYDRAULIC PUMPING ENGINE—FULLERTON, HODGART AND BARCLAY

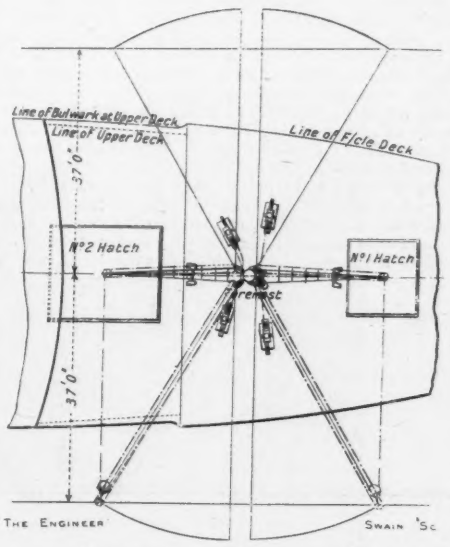


Fig. 68—LOADING CRANE—BROWN BROTHERS

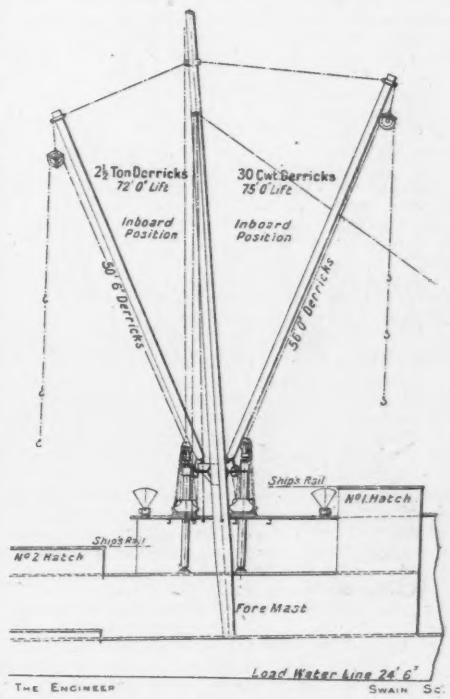


Fig. 69—ARRANGEMENT OF HOISTS AND DERRICKS

With the fortunately less frequent, but graver, class of disasters which befall ships of all kinds, it would naturally be impossible for the engineering staff to deal. These involve the assistance of specially designed salvage appliances, which are, happily, so rarely required, and are of such a cumbrous nature as in themselves to form the full equipment of vessels specially built for the purpose. No two cases of maritime disaster are capable of similar treatment. The wonderfully diverse methods of working which have been adopted within the last few years with success are still sufficiently fresh in the minds of our readers to dispense with recapitulation. We need only recall the extraordinary course of treatment applied in the cases of the Suevic and the Philadelphia. After all, however, these vessels are of such a specialised nature as barely to come within the purview of this Supplement. They are in reality only floating workshops containing similar machinery to that already described here.

Another class of machinery which we have not dealt with in this Supplement is that of power-driven launches. Naturally, our great liners trading direct from port to port are met with and attended by tenders belonging to their own companies, and, unless for drill purposes and in cases of accident, rarely have occasion to launch their small boats. They form, however, a useful adjunct to pleasure-cruising steamers, and in these cases prove a useful, if not indispensable, part of the ship's equipment. The great objection, of course, to steam-driven pinnaces has always been the time involved in their preparation for service. This objection can now, however, be overcome by the adoption of the internal-combustion type of engine. The very rapidly growing popularity of such power-driven launches in the yachting world is sufficient indication of their adaptability to the needs of the mercantile community. The inherent qualities of these little vessels need only be recalled to convince the steamship owner that their provision on board his vessels is well calculated to enhance the comforts of his passengers. A high degree of speed has already been obtained, together with economy. They can run for considerable distances with one charge of fuel, and, provided the design is a suitable one, they possess a high degree of seaworthiness. The danger inseparable from the careless handling of petrol has hitherto been the chief deterrent factor in the use of this form of power for such purposes. But, recently attention has been directed to the design of marine paraffin motors, with such a gratifying degree of success that we may confidently look for a light form of engine which, embodying the good qualities of the petrol engine, will remove the chief objection to the latter's use.

The several systems of motive power now concurrently employed on board the huge ships of modern times and the ships engaged in specialised services, together with the multiplicity of units and items involved in the auxiliary outfit of such vessels, are matters which have more and more imposed upon the engineering staff on board ship, duties and cares which the earlier sea-going engineers never had to experience, provide for, or even dream about. A higher order of intelligence and practical training and a wider range of technical knowledge are involved in the change, and even if this exists the practical skill and handicraft entailed in the proper working and maintenance of ships' auxiliaries are such as to constitute the "lot" of the sea-going engineers of each grade, like that of the Gilbertian policeman, "not a happy one." Thus it might be pointed out that in the most fully equipped of our largest liners, which in many cases carry a large amount of cargo as well as passengers, there is fitted instead of the old steam winches a complete outfit either of electric or hydraulic gear. The supervision of these appliances involves an almost specialised skill perfectly unknown to the old-time member of the engine-room staff. Of course, it may be granted that the mere control of such apparatus is becoming every day more reduced to the work performable by automata, but the very fact of such machinery being of a most intricate character demands the presence of a highly skilled specialist in the case of a breakdown of a more or less serious character. In the old days when steam was the universal motive power, and the sole form of steam engine was of the reciprocating type from the main engines to those of the pinnace, then the engine-room staff was fully competent to deal with the breakdowns or repairs of the various units. But now the recent introduction of turbine machinery in the main engine-room, and of electric or hydraulic power for lighting, loading, and steering, not to mention the probable use of petrol or heavy oil pinnace engines involves an amount of special skill and knowledge which it is impossible either to demand or to expect from a limited staff of engineers. In this connection, it may be of interest, if not of some utility, to add a few brief notes regarding the recent issue by the Admiralty of a set of instructions with reference to the distribution of responsibility for the various machinery and electrical and mechanical appliances on board his Majesty's ships. A scheme which has been under trial in the Channel and Atlantic fleets since 1903 has been approved, and is being brought into operation in all ships in which gunnery or torpedo lieutenants are borne; in other ships the present arrangements are to continue. The changes to be introduced are based on three general principles:—(1) That those who use the machinery are to be held responsible for its working and maintenance; (2) that the engineering staff should carry out large mechanical repairs to all machines; (3) that the torpedo officer is the electrical expert of the ship, and his staff should carry out electrical repairs. The engineer officer is to be regarded as the mechanical expert of the ship, and will have charge of and be responsible for all machinery, however driven, in the engine and boiler-rooms, and all steam, oil or gas-driven machinery, wherever situated. Similarly, the gunnery lieutenant will be responsible for all guns, gun-mountings, and machinery in connection with them, and the responsibility of the torpedo lieutenant will include all torpedoes, torpedo tubes, and gear in connection with them outside the point where the engineer officer's charge ends, the torpedo lieutenant being regarded as the electrical expert on whom the electrical efficiency of the ship depends.

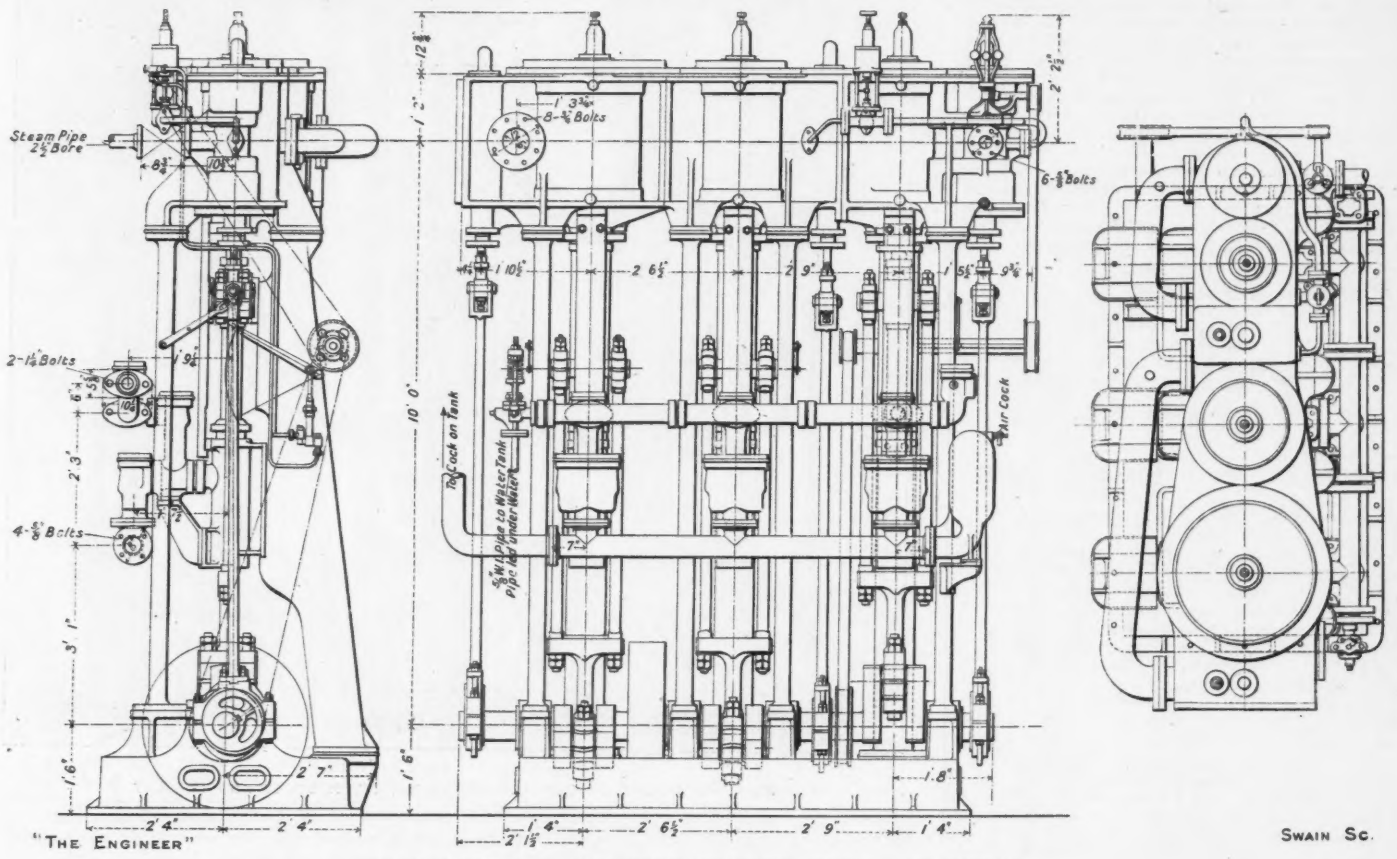


Fig. 70—HYDRAULIC PUMPING ENGINE—FULLERTON, HODGART, AND BARCLAY

## THE COVENTRY ORDNANCE WORKS, LIMITED.

No. IV.*—AMMUNITION WORKS.

No modern ordnance firm can be considered complete without placing itself in a position to manufacture everything down to the smallest detail of the whole of the ammunition required for its ordnance. Early in the existence of the Coventry Ordnance Works, Limited, the directors, realising to the full the important part played by ammunition, decided to lay down all the plant necessary for the manufacture of ordnance ammunition of every description. For this purpose they erected works at Cliffe, on the right bank of the Thames, some few miles below Gravesend and not far from Rochester, this situation being conveniently placed for the despatch of finished ammunition by water to the Royal Arsenal at Woolwich, or to Holehaven, on the side of the river for transhipment in the case of orders for friendly foreign Governments or for British stations abroad. Being at the river side, the factory is also situated so that it can readilg receive the various components and stores from the works at Coventry, where, as already explained, the cartridge cases, projectiles, percussion fuses, combined time and percussion fuses, &c., are made.

A landing stage which is to be equipped witl hydraulic lifts and hydraulic cranes, has been built out from the river bank so that the ammunition and general stores can be handled and loaded into barges at all states of the tide. The land acquired for the works is about 10 acres in extent, and the danger buildings are separated from each other in order to conform with the regulations as to distances laid down by H.M. Inspector of Explosives.

The propellant—which in the case of all ammunition supplied on British Admiralty and War-office orders consists of cordite M.D.—is stored in magazines near the loading houses. The magazines for cordite, as well as for finished ammunition, are each surrounded by earth mounds extending in height to the eaves of the building. This mounding is necessary in order to prevent as much as possible the projection of bricks and *débris* in a horizontal direction, and thus to prevent damage to the surrounding loading houses in the event of any untoward circumstance happening in the magazine.

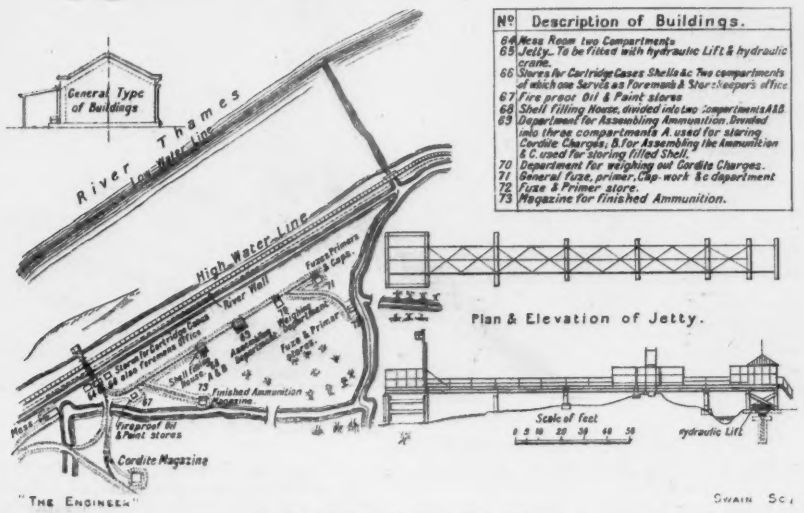
No Description of Buildings.
64 Mess Room two Compartments
65 Jetty. To be fitted with hydraulic Lift & hydraulic crane.
66 Stores for Cartridge Cases Shells &c. Two compartments of which one Serves as Foremans & Storekeepers office
67 Fire proof Oil & Paint stores
68 Shell filling House, divided into two Compartments A&B
69 Department for Assembling Ammunition. Divided into three compartments A. used for storing Cordite Charges, B for Assembling the Ammunition & C. used for storing filled Shell.
70 Department for weighing out Cordite Charges.
71 General fuze, primer, Cap-work &c department
72 Fuze & Primer store.
73 Magazine for Finished Ammunition.
General Type of Buildings
River Thames
Low Water Line
High Water Line
River Wall
Fuze Primers & Caps
Fuze & Primer Stores
Finished Ammunition Magazine
Fireproof Oil & Paint stores
Cordite Magazine
Plan & Elevation of Jetty.
Scale of feet
Hydraulic Lift
"THE ENGINEER"
SWAIN Sc.

Fig. 29—CLIFFE AMMUNITION WORKS

for the workgirls. The very appearance of these neat-looking girls, trooping laughingly from the loading-houses towards the dining-room on the signal for cessation of work at mid-day would seem to point to excellent relations between management and the workpeople, and we are informed that, in times of stress, when the output of ammunition required taxes the strength and endurance of management and workpeople alike, all respond nobly to the call, and justify to the full the mutual confidence and esteem engendered by the thoughtful treatment meted out by the directors.

Close to the girls' dining-room, and between it and the foreman's office and shell and cartridge stores, is the landing stage already referred to. The hydraulic lift, also mentioned above, is necessary, because the stage has had to be carried some little height above the ground in order to pass over the river banks. Closed ammunition trolleys, filled with packages arriving from the finished ammunition magazine, are lifted to the level of the landing stage and wheeled along it—always under cover—to the end, which is made so that it overhangs a barge brought beneath it.

Opposite the landing-stage and distant some thirty yards are the oil and paint stores, which are built of iron and brick only, and have cement floors. In these stores all materials of a combustible nature are kept. Further on are the danger buildings. These are all lightly constructed timber erections, built in accordance with the Home-office regulations, the minimum distance between each pair of neighbouring buildings being 50 yards. A system of light tramways links them all up, bringing each into communication with the magazine, as well as with the landing stage. Various ammunition is here made up, from the smaller quick-firer fixed ammunition, complete in itself, to the larger breech-loading cordite cartridges sewn up in silk bags with priming charges of black gunpowder at either end enclosed in red shalloon.

The following account of the manner in which the manufacture of the 18 pr. Q.F. ammunition—for which the company at present holds a large Government contract—is carried out will doubtless be of interest.

The cartridge cases, projectiles, primer bodies and fuses are made, as already explained, at Coventry. These various components are brought partly by water and partly by railway, and are kept in the various stores allotted for their reception. Then, as required, they are brought out; the metal primer bodies go to the primer house, where they are filled with a priming charge of gunpowder and sealed. Finally, by means of an ingenious machine, by which it is claimed that all danger is obviated in the event of an accidental ignition taking place under the process, they are each fitted with a percussion cap. Careful testing of a percentage of caps before use reduces the chances of miss-fires or hang-fires arising from the use of faulty material in this department to a minimum.

In the meanwhile, in another danger building M.D. cordite used for the propelling charge, having been drawn from the magazine, is cut to the exact length required, carefully weighed out and tied into bundles. It has been found, so we are informed, that the employment of girls for this work gives very satisfactory results, and that the rigid inspection carried out by the management rarely shows any deviation from the exact weight of cordite required by the specification being worked to.

Simultaneously the shrapnel shells have been filled with their bursting charges of gunpowder and either plugged or fitted with fuses as the particular contract may require. There are now the propelling charges of cordite, the percussion primers and the projectiles all prepared, and it only remains, therefore, to assemble these various components into complete rounds of finished ammunition. For this purpose covered trolleys take all the components to yet another house, which is separated from its neighbours by the usual 50 yards. Here the assembling is carried out by male labour, the work requiring considerable strength and endurance. The shell having been carefully inserted into the cartridge case, which already contains its cordite charge, the round is taken to an indenting machine, which compresses the metal of the case firmly into a cannelure running round the projectile below the driving band. By this process the projectile is firmly attached to the cartridge case, making what is said to be an air and water-tight join, and one not likely to become loose during the hard jolting received on active service.

Last of all the percussion primer is screwed into the base of the cartridge. This finishes the round of ammunition, which is now ready for gauging and packing. A complete system of measuring and gauging has been instituted, and it is not only employed during the manufacture of the components, as already explained, but also in a final and rigid inspection of the finished cartridges. The latter, after being packed in wooden boxes, are then stowed away in "lots" in the magazine ready for despatch.

Throughout all the above operations very careful tests are made both in ballistics and in visual and chemical inspection of the explosives employed. The ballistics and fuse trials, as well as penetration and bursting tests of armour-piercing shells and other projectiles contained in the various kinds of ammunition manufactured at the works, will all be carried out at the company's range near Boston, in Lincolnshire.

This range, we may state, is not as yet fully equipped, but we understand that the work in connection with it is proceeding rapidly. There is no doubt that one of the most pressing requirements of a firm of ordnance manufacturers and one of the most difficult to obtain is a really satisfactory site for a proving ground. Yet the Coventry Ordnance Works would seem to have been particularly fortunate in this respect. After a search extending over a considerable period a site was found upon the Lincolnshire shore of the Wash, some four to five miles from the town of Boston. Here the total available length which has been leased from the Crown on the foreshore is no less than 22,000 yards, or about 12½ miles. In some parts the range is as much as 3½ miles broad. A plan of it is shown in Fig. 31.

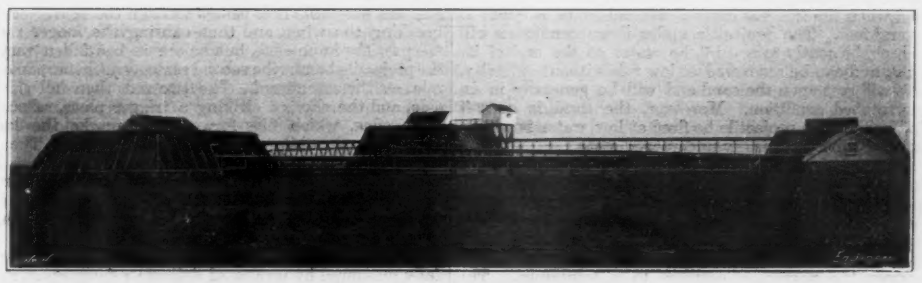

Fig. 30—GENERAL VIEW OF CLIFFE AMMUNITION WORKS

Fig 31—PROVING RANGE NEAR BOSTON

The accompanying plan, Fig. 29, will serve to assist our readers in understanding the following description, and Fig. 30 shows a portion of the works, the whole of which is an example of order and neatness. Each building in the "danger area" is numbered, and each has a notice board fixed over the door upon which

* No. III. appeared June 14th

# GERMAN LIGHTHOUSES

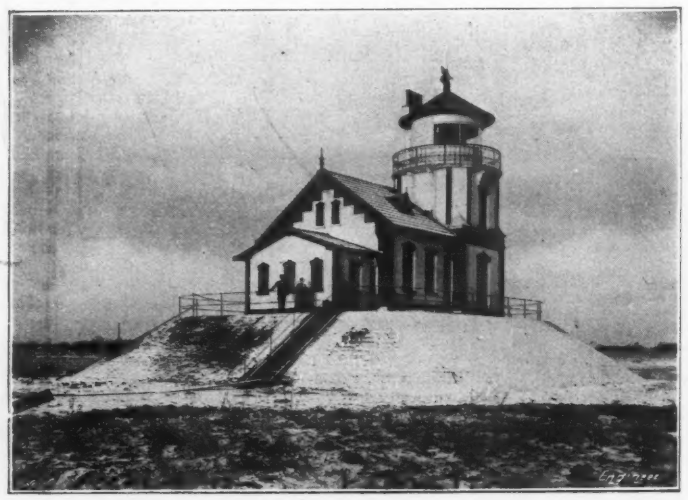

Fig. 1—BUTZFLETHERSAND LICHT

Fig. 2—SWAKOPMUND LIGHT

The whole length of 22,000 yards is on a practically level surface of sand, and range parties when the tide is out can be stationed at any desired points down the range to observe the results of the practice and to recover projectiles. The latter is a feature of importance when the laying out of a range is under consideration, for when firing experimental projectiles or fuses little or nothing can be learned unless the projectile can be recovered in the same condition as when it left the muzzle of the gun. In this respect it is said that the Boston range will be unique in this country on account of its length and suitability.

Twice a day the whole range will be covered by the sea with the exception of the gun platform, plate butts, &c., and an experimental shell or fuse, for instance, which it is desired to recover after trial, will be able to be fired when the tide has covered the range to a depth of several feet. The projectile under these conditions will be brought gently to rest in the water at the end of its flight, and can be recovered at low tide without difficulty, as it will rest upon the sand and will be generally in an unscratched condition. Moreover, the sand is so soft that even if the projectile be fired at low water it will be recovered in a practically undamaged state.

In the choice of the site the directors were influenced first and foremost by this suitability of the foreshore; and, secondly, by the fact that at no other position are the difficulties of transport so easily surmounted. The range is situated on that part of the coast line which is nearest to the company's works at Coventry. This reduces the necessary carriage to a minimum. The material will be brought by railway to the dock quays at Boston, and then placed in a barge specially designed for the purpose. It will then be taken down the river to the gun platform, which will be distant some 4½ miles by water. As the barge will be flat-bottomed and of but small draught, it will be possible to take it under the gantry to be situated above the gun platform at any high tide, and to discharge its freight at once. It will be possible, we are informed, to lift guns and mountings from the barge and deposit them in position upon the iron platform in a few minutes, while armour plates weighing 12 to 15 tons or more—according to size—will be taken by the barge to the plate butts, which are to be situated some 200 yards from the gun platform, where they will be lifted out by a specially-designed crane, and placed in position for testing.

Provision will also be made alongside the plate butts for stopping projectiles which are merely fired for the measurement of velocities. This will be brought about by receiving them into a sand tunnel, which will consist of a strongly built tunnel filled with sand, covered by heaped up earth and lined internally with steel plates.

The gun platform will consist of a solid block of concrete upon which is to be firmly bolted down an iron plate grooved over its whole upper surface with channels to retain the heads of the bolts serving to hold down the gun mountings. Next to this will be buildings which will be employed as tool stores, workshops, &c. These are to be fitted with appliances and tools for making any small alterations or adjustments to the guns and carriages which the firing trials may suggest.

The chronograph house is to be erected several hundred yards from the gun platform in order to prevent the shock of discharge of the heavier guns from upsetting the adjustment of the delicate apparatus it will contain. In it will be carried out the important operation of measuring the muzzle velocity of the projectile, from which the proper sighting angles may be calculated, and also the time of flight and the angle of descent. So many factors, however, such as shape of head, driving band, &c., influence the actual trajectory obtained, that one of the most important duties of the range officer is to correct results foretold theoretically by measuring and noting any discrepancies which may occur. Thus an accurate range table may be prepared for each gun as it passes through his hands. Indeed, without an experimental range it may be said that it would be impossible by mathematical means alone to reach satisfactorily a high standard of efficiency.

The chronographs, of which there are to be two, will be of the Boulenge type, and they will be placed on solid brick piers. They are necessarily of extreme delicacy and accuracy.

We may explain that this instrument consists essentially of a metallic rod having a soft iron point which, when released, can fall vertically past a steel knife edge held back by a trigger arrangement until released by a similar but considerably shorter rod. Each of the two rods is held in position by an electro-magnet, in the circuit of each of which is placed a screen of fine copper wire, so arranged that no projectile could pass through without cutting the circuit. These two screens are placed in the path of the projectile at accurately measured distances on the range from the gun, the nearer one being connected to the magnet on the chronograph from which the longer rod is suspended, and the second being connected to the magnet which holds up the shorter rod. On firing the gun the projectile first passes through the nearer screen, breaking the wires, and thus causing the longer rod to fall past the knife edge, but before it has fallen very far the projectile breaks the second screen, and instantaneously releases the second rod. The two rods then fall side by side, and the shorter, striking a trigger plate, releases a knife edge, which flies forward and marks the longer metallic rod while it is still in the air. The distance from a zero line of the mark thus made is a measure of the velocity of the projectile. In all the more important trials two instruments will be employed, and the readings taken in duplicate. An average will then be struck between the two results.

In the case of the proof of a gun, the bore is first carefully measured by means of delicate micrometers, and a record of it is entered up in a book specially kept for the purpose. The gun is then fired several times, the charges being gradually increased until the desired proof pressure, varying with the nature of the gun, is obtained. It is then returned to the examiners for re-measuring, and the measurements obtained are carefully compared with those obtained before firing was commenced. If these two sets only vary very slightly from each other the gun is pronounced satisfactory.

For the purpose of measuring the maximum pressure which is created in the chamber of the gun at each round, a simple apparatus or "crusher gauge" is employed. It consists essentially of a steel cylinder closed at one end and fitted at the other with a screw cap accurately bored to receive a steel piston. Within the crusher gauge is placed a short cylinder of soft copper, the length of which is accurately known, and the piston is pushed down until its end presses on the copper. The gauge thus prepared is placed within the charge of propellant, and, upon firing the gun, the pressure exerting itself in all directions, forces the piston down upon the copper, shortening or crushing it in proportion to the amount of pressure acting on the face of the piston. Afterwards the exact length of the copper is measured, and a comparison of the original and final lengths gives a measure of the pressure it has undergone.

Operations such as set out in the foregoing will all be managed at the company's range, and another important branch of work which will be carried out there will be the testing of armour plates and armour-piercing projectiles, both capped and uncapped. These will be manufactured by Cammell Laird and Co. and John Brown and Co., two of the allied firms. These trials require very skilful manipulation. The plate will be erected on a special framework designed to resist the powerful blows which the projectiles of heavy modern guns are capable of delivering. Provision will be made for catching the projectile for examination should it succeed in perforating the plate, and for retaining all splinters in the event of the projectiles being smashed into pieces, as not infrequently happens.

Other trials will consist of fuse testing—both of the time and percussion varieties—by firing at various elevations over the sands. In addition a careful check will be kept of the quality of the ammunition manufactured at the Cliffe works by making ballistic trials of all finished ammunition, as well as settling the charges necessary by actual chronograph measurement.

A large magazine for storing cordite or other propellants used in the experiments, various erections used as general stores, a splinter-proof shelter for the staff and workmen while firing is proceeding, a handling room for weighing out and making up the cartridges, with hot water heating apparatus, will form some of the buildings comprised in the equipment of the range. In addition there is to be an electric lighting plant for illuminating the various buildings, gun platform, &c. This will be driven by an oil engine, which is to be also available for driving the machinery in the workshop.

This range will complete the equipment of the Coventry Ordnance Works, Limited. From what has been said, it will have been evident that great pains have been taken to render everything as complete as possible. The object in forming the company and in building the works was evidently to provide just those things which the allied firms either had not got, or had not got enough of. Now, combined they will be enabled to carry out any operation connected with the construction and equipment of warships of whatever size and fighting power, besides being able to undertake any military work. It is certainly a bold bid for fortune which has been made, and we sincerely trust that it may be successful.

## SOME NEW GERMAN LIGHTHOUSES.

GREAT improvements have been made within recent years in lighthouse practice on the German coast. In 1903 the lighthouse at Travemünde, which controls the

Fig. 3 -TRAVEMUNDE LIGHT

entrance into Lubeck, was equipped with electric light. It is a brick structure, having been in existence for a number of years, as may be seen in Fig. 3. The modern tendency, however, is to erect steel structures for the higher stations. Examples of the steel lighthouses are those of Bützflethersand and Wisch on the Elbe, which were put into operation in the spring of this year. These are shown in Figs. 4 and 5.

The Travemünde light is equipped with a parabolic reflector, and is stated to have a power equivalent to

400,000 Hefner candles. The group of four lighthouses which has just been built on the estuary of the Elbe has made the navigation of the river toward Hamburg much safer. Two of these, at Bützflethersand and Wisch, are, as already mentioned, high steel erections, and the others at Bützflethersand—Fig. 1—and Mühlenstack—Fig. 6—are comparatively low. The two former are equipped with powerful fixed lights, whilst the lanterns of the two latter send out flashes. The mechanism is worked by compressed air, which the attendant compresses during the day by means of an air pump. The lights of the new lighthouses are of the incandescent petroleum vapour

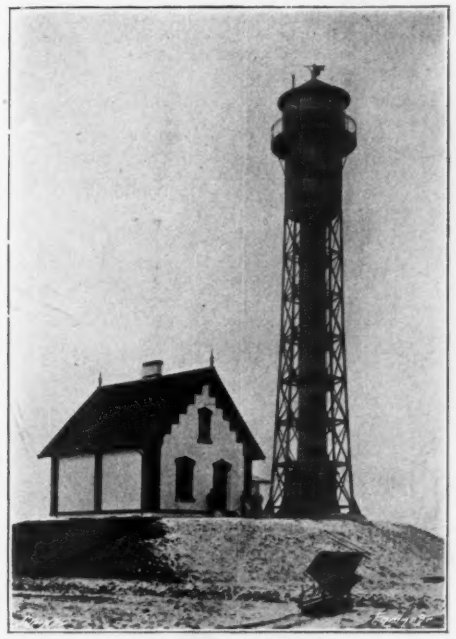

Fig. 4—BUTZFLETHERSAND LIGHT

type, which in economy and intensity is stated to be superior to anything previously known. Nearly all the German lighthouses on the North Sea and Baltic Sea are now being converted so as to use incandescent petroleum lights. Air is pumped into the petroleum tanks at a pressure of 2¾ atmospheres, and the oil is vaporised and burned in burners of special construction manufactured by the firm Julius Pintsch, of Berlin. The incandescent mantles used in conjunction with these lamps have diameters ranging from 30 mm. to 100 mm. A mantle of 30 mm. diameter with the incandescent petroleum vapour burners gives a light having a candle-power of 860 Hefner candles, whilst the mantles of 100 mm. diameter emit a light of 4000 Hefner candles. The fragility of the incandescent burner is a drawback which has not yet been overcome; but many devices are known which protect the mantles from

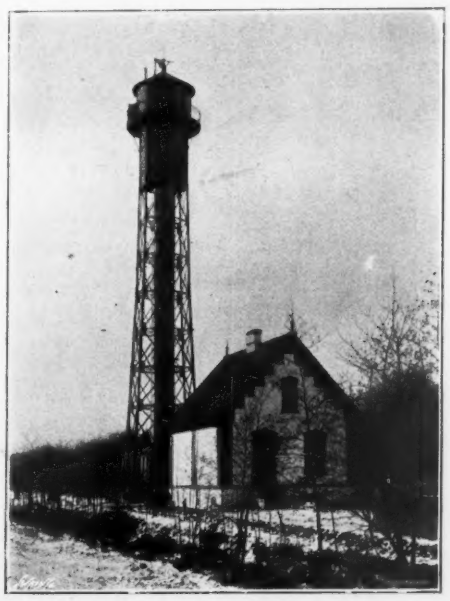

Fig. 5—WISCH LIGHT

shocks and vibration. A good mantle will last for a week or two, and the ash of broken mantles always obtain a good price from the mantle manufacturers on account of the thoria which it contains. The vaporiser of the burner needs to be warmed up before ignition by means of a small spirit lamp, but the operation is then automatic. The four lighthouses on the Elbe mentioned above were commenced in 1906 and put into operation in March this year. They have taken a little over twelve months to build. The iron framework of the two high lighthouses is painted white. It will be interesting to know how the economy effected by substituting steel framework for the brick towers compares with the increased expense associated with frequent painting.

The small lighthouse at Scheelenkuhlen—see Fig. 7—is near the entrance to the Kaiser Wilhelm Canal, and also assists in the navigation towards Hamburg.

Fig. 6—MUHLENSTACK LIGHT

The development of Germany's oversea possessions has necessitated the erection of a number of lighthouses on the African coast. In Cameroon there are three light-

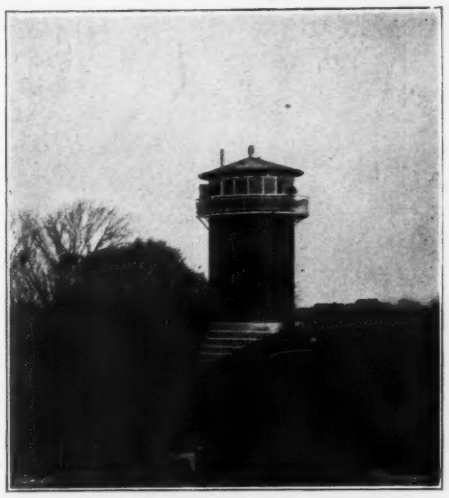

Fig. 7—SCHEELENKUHLEN LIGHT

houses, Kap Debundscha—Fig. 8—and Kap Nachtigall—Fig. 9—erected in 1903, and Kribi—Fig. 10—which was completed in 1906. Kap Debundscha is the highest of the

Fig. 8—KAP DEBUNDSCHA LIGHT

lighthouses in Cameroon, being about 90 m. above sea level. It is equipped with a fixed light, which can be seen for twenty-eight miles. The lighthouses at Kap Nachtigall and Kribi, the lanterns of which are 43 m. and 15 m. above sea level respectively, are equipped with rotating lights. The candle-power of each is about 100,000 Hefner candles. They are superintended by blacks, since the climate is too unhealthy for whites. The Cameroon lighthouses are of great importance for the West African navigation. Vessels leaving Lagos make first for the light at Kap Debundscha, sailing north of Fernando Po. The next point is Kap Nachtigall, which protects the entrance to Victoria. Kribi is further south. The light at Kap Nachtigall is of peculiar interest. The double tower with the central arch was built in 1901 in

Fig. 9—KAP NACHTIGALL LIGHT

memory of Bismarck. In 1903 the lantern was placed on the top of one of the turrets, so that the erection now serves the double purpose of guiding mariners to the port of Victoria and reminding them of the founder of Germany's Colonial Empire.

In German South-West Africa there are lighthouses at Swakopmund and Angra Piquena. The lighthouse at Swakopmund—see Fig. 2—which was the first of these two to be erected, was built in 1903 by the firm of Julius Pintsch and is stated to have cost about £2500. The light has a power of 100,000 Hefner candles, and can be seen for a distance of about 25 miles. The optical apparatus of

Fig. 10—KRIBI LIGHT

the rotating type is driven by clockwork mechanism and floats in a mercury bath. All the lanterns in Cameroon and German South-West Africa are fitted with the usual concentric oil wick burners.

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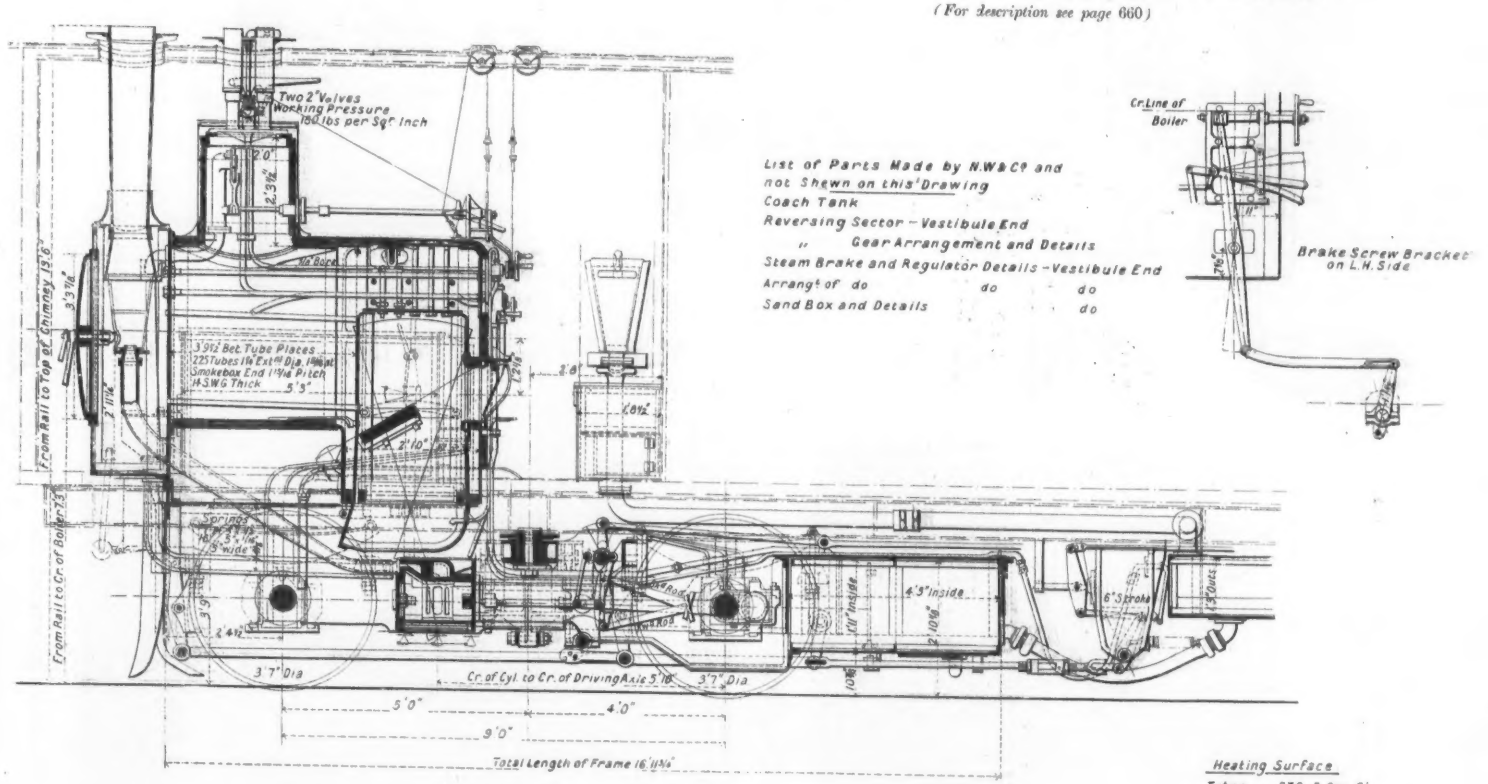
DREDGING experiments have shown that it is possible, by cutting away a small portion of the Sheerness bar, to secure a channel from the Nore to Sheerness Harbour with 25ft. of water at low-water of spring tides, instead of 19ft. as at present. Such a channel would enable the Medway to be entered or left by heavy warships at any time on certain tides.

# ENGINE OF MOTOR COACH FOR EAST INDIAN RAILWAY

NASMYTH, WILSON AND CO., LIMITED, PATRICROFT, ENGINEERS

*(For description see page 660)*




List of Parts Made by N.W.& Co and not Shewn on this Drawing

Coach Tank

Reversing Sector – Vestibule End

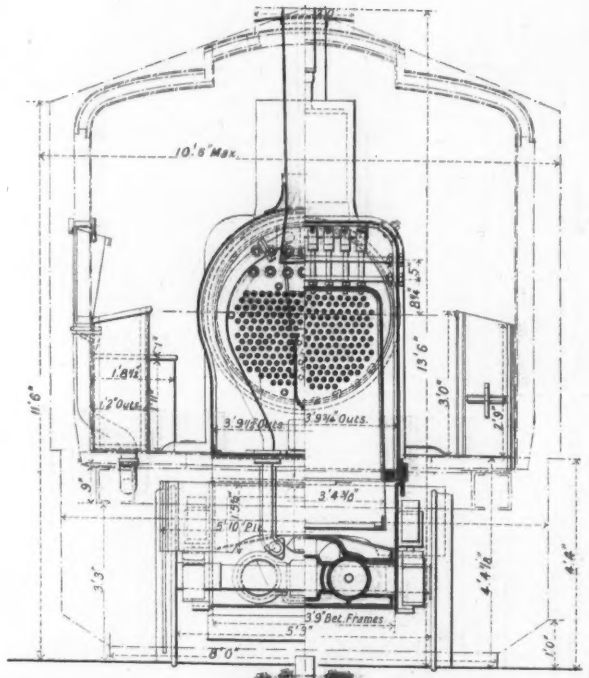
" Gear Arrangement and Details

Steam Brake and Regulator Details – Vestibule End

Arrang^t of do do do

Sand Box and Details do




Heating Surface

| | | |
|---|---|---|
| Tubes | 279·5 | Sq^r F^t |
| Fire-box | 43 | " " |
| Total | 322·5 | " " |

Grate Area 7·5 Sq^r. F^t

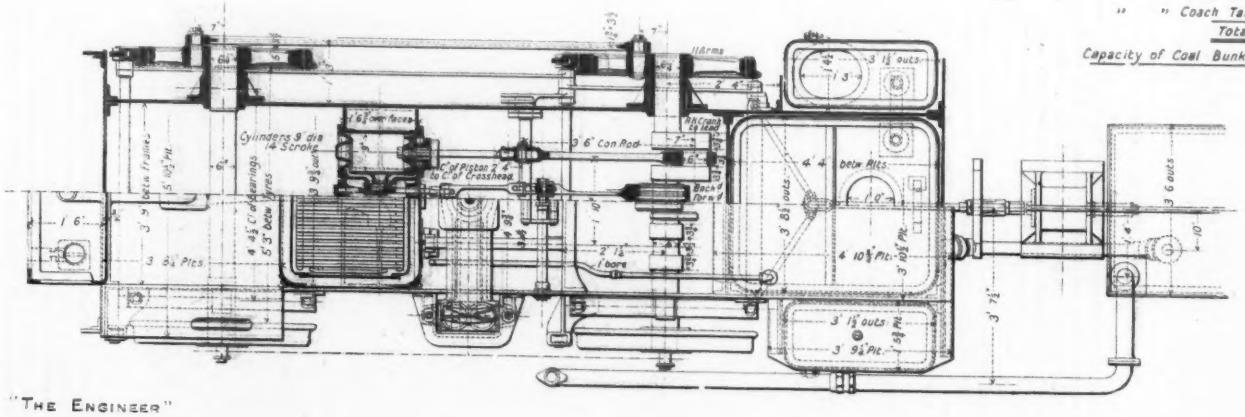
Capacity of Centre Tank 184 Gallons

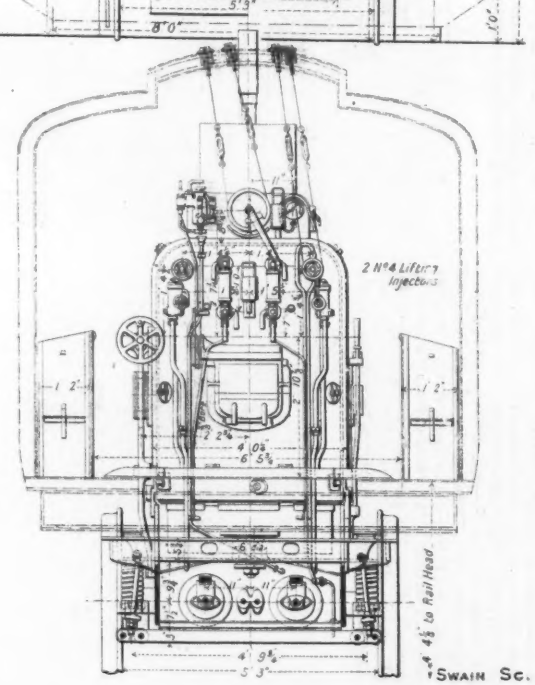
" " Side Tanks 96 "

" " Coach Tank 220 "

Total 500 "

Capacity of Coal Bunkers 35 Cubic F^t




"THE ENGINEER"

SWAIN Sc.

## THE CONFERENCE OF THE INSTITUTION OF CIVIL ENGINEERS.

### SECTION I.—RAILWAYS.

On Thursday, 20th, at the second meeting of Section I., three papers were read and discussed. The first of these, by Mr. H. R. A. Mallock, F.R.S., was on

"THE ACTION BETWEEN WHEEL AND RAIL."

It possessed no practical value. It is simply an ingenious attempt to arrive by assumption at what goes on when a loaded wheel runs over a rail. To use the author's words:—"If a steel cylinder of a certain radius and width rests on a flat steel rail of the same width, and carries a definite load, how much will the cylinder depress the rail and how much will the rail flatten the cylinder?"

In attempting to supply an answer the author took no account whatever of the fact that the sleepers yield and the rail bends, and gave the following general formulas connecting the radius of the wheel $r$, the length of arc $a$ in contact with the rail, the width of the tread $b$, and the total elastic supporting force of the rail F,

$$a = c_1 r^{\frac{3}{4}} b^{\frac{1}{4}}$$
$$F = c_2 r^{\frac{3}{4}} b^{\frac{1}{4}}$$

If the units are tons and inches, and assuming that 20 tons per square inch is the greatest load which can be laid on a plane of the material without causing permanent set, and that the compression produced by a pressure of 1 ton per square inch is $\frac{1}{2100}$ of the square root of the area over which it is applied, $c_1 = 0{\cdot}0165$ and $c_2 = 0{\cdot}46$.

The general conclusion at which he arrived is that it is to be expected that wear will be very rapid at first, while the contact areas are small, and will diminish in rate subsequently. A subsequent speaker, however, said that in practice the contrary is the rule.

The discussion which followed showed by its animation that many engineers are interested in the subject. Much of the ground covered the day before in the discussion on Mr. Sandberg's paper was traversed again. Unfortunately, matters were left much where they were. Attention was called to the fact that with electrical stock the excessive wear was not confined to the rails; the wheels also suffered. Much good was done by greasing the check rail with some coarse oil twice a day. The life of check rails was increased in this way from six months to twenty months. Professor Carus Wilson cited some experiments which he had made with steel cylinders rolling on glass bars. From the results he deduced that the stresses varied not as some power of the load, as stated by Mr. Mallock, but directly as the load. Further investigation of rails showed that, curiously enough, the top table, which ought to be subject to compressive stress, was really put in tension by the wheels, the action of which was to roll out the rail much as a cook rolls out dough. The microscope revealed multitudes of hair cracks in the table, and if a rail in this condition was turned over it was certain to break almost immediately by the spreading of one of these cracks. Mr. Hopkins drew attention to the time element. A wire which would only carry 500 lb. of steady stress easily bore 840 lb. for one-thousandth of a second. It would be interesting to know if slow trains did more mischief than fast trains. Mr. Burnett said that the fault was in the rolling stock. The bogies were too short, and the brakes made them rigid. Following speakers called attention to the difference in material of tire and rail, and to the fact that subsoil had no effect. Mr. Benedict found that ridges were bright and hollows dark, and asked if ridges travel along the rail. Then the discussion branched off to tramways. It was said that the electrical stock was modelled on the tram-car, which was a great mistake. Mr. Howley, who has a large experience in electric tram lines in Birmingham, said that he found corrugated rails everywhere. The rail head got rolled out. The remedy lay in the rail. He found that in roaring rails the ratio of carbon to manganese was always low. The cold rolling which went on was due to excess of manganese. A high carbon rail will not roar. When the carbon is under 40 per cent. of the manganese roaring occurs.

After a few words of reply by Mr. Mallock, the next paper taken was by Mr. W. Dawson on

"A SYSTEM OF AUDIBLE SIGNALLING ON RAILWAYS."

It has been felt by railway officers and by the inspecting officers of the Board of Trade that no device would meet the requirements of the situation unless it would give the driver of a train a distinct audible "danger" signal, and a distinct audible "all right" signal; further, that the device must not depend on electricity to give the "danger" signal, and that should there by chance be any failure in the mechanism the result must be the sounding of the audible "danger" signal. Such an apparatus has now been designed, and has been in use on the Great Western Railway on a short branch double line for fifteen months, supplementing the ordinary fixed outdoor visible signals as a first test; and as a more advanced experiment it has been in use for the past five months on a single line—22 miles long—in total substitution of the semaphore distant signals, which have been removed. During these experimental periods the apparatus has given great satisfaction, and the drivers and their officers have every confidence in it.

The main features of the system are as under:—The parts consist of a slightly arched piece of timber, 40ft. to 60ft. long, bolted to the sleepers midway between the two running rails, on top of which is bolted a bar of T iron suitably mounted and insulated, the bar being electrically connected by means of a length of telegraph wire to a switch at the signal-box. The bar is electrified by pulling a lever when it is desired to give the "all right" signal. There is no moving part in this ground apparatus. This fixed non-movable sloping bar also serves the purpose of lifting a rod connected with a mechanical device fixed beneath the engine of a standardised design to fit any engine. The lifting of this rod opens a small steam whistle fixed in the cab of the engine when it is desired to give the "danger" signal. To give the "all right" signal the action set up by the electrified bar on the ground apparatus restrains the whistle from blowing but rings a bell. When the whistle or the bell sounds, either continues to do so until the driver shuts it off, and without any further action on his part it is ready to produce the same signal again at the next station.

The discussion was opened by Mr. Jacomb Hood, chief engineer to the London and South-Western Railway. He said the time available for the discussion of so important a subject was too short. The question of substituting audible for visible signals involved very serious issues. Hundreds of attempts had been made to get good automatic signalling, which all broke down in details. If a really trustworthy electric system could be found, it ought to effect an enormous economy. On his line the cost of maintaining signals was £30,000 a year, or £32 per mile, or ¾d. per train mile. Mr. Ross said that the danger of impact at high speeds might be got over by a system of magnets placed in the track which set the signal apparatus in motion as the train passed. The great difficulty was that while automatic signals told the driver to stop, they did not tell him when to go on again. Colonel Yorke, R.E., Board of Trade, said that audible signals had been tried on the footplate since 1840. He spoke in very high terms of the honesty of purpose and care taken by fogmen. It was a great thing to say that he had never heard of an accident which could be attributed to a fogman. Any automatic system must be kept in constant use summer and winter. If it were not, it would be found wanting at the critical moment. If a system was considered good in the stress and danger of a fog, it must surely be excellent in bright weather. Besides, duplicate systems might prove disconcerting to a driver. He thought that the system described might answer admirably for distant signals, which were caution signals, the train not stopping; but he thought that hand-signalling ought to be retained for home signals. It was most desirable to arrive at the views of drivers. Mr. Blackhall said that they had the Dawson system in use on the Great Western for two years without a single failure. They had now 70 miles of main line fitted. Mr. Marsh, of the London and Brighton Railway, said that the drivers must be considered first of all. By long practice they acquired a species of instinct which enabled them to locate a signal as a man coming downstairs in the dark in his own house can go straight to the electric light switch. They must keep the human element in view continuously. On the Great Northern an automatic signal had been tried, apparently with success, but it had to be removed as the drivers "didn't think very much to it." That is, they were accustomed to one system, and did not take kindly to another.

The third and last paper was by Mr. W. Barrington,

"ON LIGHT RAILWAY POLICY."

This paper contained absolutely nothing new or of engineering interest. The sum and substance of the discussion, which few people remained to hear, was that the law and the lawyers were very largely to blame for the smallness of the mileage of light railways in this country. Furthermore it was not certain that light railways gave satisfaction. Unless special and costly expedients were adopted, goods had to be transhipped at junctions with main lines. Farmers would not have this, and preferred to cart their goods to the main line station. Much had been hoped from the use of the highways by running the railway along them. The result had been quite unsatisfactory, for the speed had to be kept down, and if people travelled by rail at all they wanted to go fairly fast. The conclusion was hence reached that there was really no money in light railways, save in a few exceptional cases where two towns were linked together. One, for example, was cited, five miles long, but it had cost £7000 a mile, and had practically no competitor.

This brought the proceedings of the section to a close. We must add a word of praise to Mr. Galbraith, who made an ideal chairman—the iron hand in the velvet glove. There were times when he had no small difficulty in restraining diffuse speakers who forgot how time pressed; but he never gave offence, and fully earned the thanks of all who came under his rule.

### SECTION II.—HARBOURS, DOCKS, AND CANALS.

The proceedings in Section II. re-opened on Thursday with the reading of Mr. W. W. Squire's paper on

"DOCK EQUIPMENT, INCLUDING THE RELATIVE ADVANTAGES OF ELECTRIC AND HYDRAULIC APPLIANCES,"

in which the author states that according to his experience hydraulic power is preferable to electricity for opening and closing dock-gates and for actuating slow-moving machinery. For cranes and lifts the advantage in working appears to be about evenly balanced, though the first cost of the hydraulic appliances is somewhat lower. Electric power is eminently suited for conveyor bands and all kinds of lifts, and generally for plant to which rotary engines are applicable. Also for workshop equipment in connection with docks, electric appliances are proving their superiority. Electricity also has the advantage of being employed for internal and external lighting; while the hydraulic installation can be utilised for supplying water for extinguishing fires.

The discussion which followed the reading of the paper, and occupied the greater part of the morning sitting, was opened by Mr. E. B. Ellington, who laid stress on the advantages obtained by the use of hydraulic power for many classes of dock equipment.

Mr. A. G. Lyster having called attention to the usefulness of floating cranes of high power, which could be taken alongside the vessel instead of having to move the ship to some particular berth in the dock, said, leaving out of consideration the question of lighting, hydraulic power could perform everything required in connection with the mechanical appliances for docks. It had the great advantage of simplicity, needed little attention, and entailed a comparatively small outlay on repairs. He questioned whether it was desirable to run a dual system of power supply in connection with a dock undertaking—electric and hydraulic. Gas lighting was now so efficient, and undoubtedly the most economical means of illumination, that electricity could be dispensed with for the purpose. He had found gas engines more economical than electric motors for graving dock pumping, and they were very efficient. At Liverpool they had such large variations in the total load that no system of electric power could compete with hydraulic on the point of economy. He had had a lengthy series of load diagrams prepared extending over a fortnight, and the total load curve prepared from them exhibited the most remarkable variations.

Dr. E. L. Corthell said that he had occasion during the last few years to make careful inquiry into the relative merits of hydraulic and electric power for dock equipment, and at the request of the Brazilian Government he had sent a commission of engineers to Europe to investigate existing systems and report fully. This report, which was a most valuable one, clearly proved the superiority of electric power, especially when a dock plant had to be created *de novo* and there was no other system already installed. As the result of his inquiries, he had decided to equip four ports now under construction in South America with electric plant throughout. These were practically new ports, and of first-class magnitude. At Rosario, where they were spending over 2½ millions sterling, the entire equipment would be electric, and the same applied to the three Brazilian ports where he was engaged on large harbour works, namely, Para, Rio Grande de Sul, and Pernambuco. At Santos they had hydraulic power for cranes, as well as steam power, but they were soon to take out the hydraulic installation and substitute electricity. At Buenos Ayres the equipment was formerly worked by hydraulic power, but they were substituting electricity for it. In the United States the movement was also towards the use of electric power for such purposes. The Buffalo and Albany Canal, a work involving the expenditure of several millions sterling, and including large docks and every kind of mechanical dock appliance, was to be worked electrically.

Mr. W. Pitt admitted that hydraulic power had advantages for certain purposes in connection with dock equipment, especially when extensions of existing plants had to be made. But for new ports electricity was the best form of power for the entire installation. The flexibility of electric transmission was the principal argument in favour of its adoption.

Mr. W. H. Hunter said that 27 per cent. of the import traffic on the Manchester Ship Canal was handled direct into truck from the ship without passing through sheds. They had about seventy hydraulic and seventy electric cranes at work; of these the hydraulic cranes were the older. The undoubted advantage of electric power had led him to adopt it for working the new grain elevators. He would, if called upon to-morrow to decide on the equipment of the canal with a power system *de novo*, put in electric plant on account of its great adaptability and flexibility. For dock-gate machinery hydraulic power still had considerable advantages, and for capstans it was in every way the best from all points of view. The trouble with electric capstans was almost ceaseless, owing to the working parts being of necessity placed underground. He had made a trial to ascertain the relative working expenses of two sets of cranes, one electric and the other hydraulic, engaged in unloading similar cargoes, and under exactly similar conditions. With electricity at 1d. per unit, and allowing for cost of plant, mains, &c., the cost was very slightly in favour of hydraulic power. Electric plant cost less to maintain, but the first cost was about 60 per cent. higher than hydraulic. Taking everything into consideration, there was equilibrium between the costs of the two systems, but on the score of convenience he would favour electric power.

Mr. S. Humphrey spoke in favour of hydraulic power, and alleged that in the United States there was a growing tendency to prefer it to electricity.

Mr. C. S. Meik said that at Swansea the average cost of handling a ton of goods by hydraulic power, including interest and depreciation, but excluding power, for the year 1906, was 1·411d. Power, including interest and depreciation, came out at ·377d. per ton, bringing the total cost per ton to 1·788d. The new works at Swansea will probably be equipped with two systems—hydraulic for coal hoists and dock machinery, electric for cranes, &c. The flexibility of electric power for cranes was a great advantage, and for such purposes he considered it the best; but for gate machinery, coal hoists, and similar plant working under constant load, hydraulic power was less costly.

Mr. G. N. Abernethy said that in many places docks could take advantage of a town electric supply for working small plant, light cranes, and for lighting, retaining hydraulic power for other machinery.

Mr. C. E. Vernon said that at the London Docks they found it absolutely necessary to have both systems—hydraulic for gates and sluices, electric for cranes and other purposes, and for their customers who might desire to use electric power.

At the request of the Chairman, Mr. Humphrey gave some particulars of the precautions necessary to prevent damage or stoppage by the freezing of hydraulic mains, &c., in very cold weather. In this country, he said, they never had much difficulty. If mains are laid 2ft. under ground they are immune, and above ground all that is necessary is to protect the pipes by boxing and wrapping. For special small installations glycerine could be mixed with the water to prevent freezing; but in large plants, when this was impracticable, reasonable care was all that was necessary.

Mr. Lyster added that at Liverpool they place gas jets in the pits when hydraulic pipes are otherwise unprotected. Pipes above ground are protected by wood boxing and sawdust, and walking pipes are wrapped. Cylinders are usually boxed in.

The Chairman—Sir William Matthews—in closing the

discussion, said he agreed with Mr. Squire that for heavy work such as dock gate machinery and capstans hydraulic power is much the best, but for crane work the advantage lay with electricity. He thought that in many cases a dual system was necessary. Engineers in this country seldom had the good fortune to be engaged in laying down entirely new power systems on large dock undertakings where the choice was not complicated by the existence of plant and machinery already in use, and he congratulated Dr. Corthell on having four great works of this description under his direction.

At the afternoon session three papers dealing with dredging operations in varying forms were discussed. The first was on

"DREDGING IN THE SEA CHANNELS OF THE MERSEY,"

by Mr. Lyster. It brings up to date the information that the author gave at the former conference in 1899. Since then the two suction dredgers, G. B. Crow and Brancker, each of 3000 tons capacity, have been kept almost contantly at work at various points in the main channel.

The total quantity of sand removed from the bar, the Crosby and other channels, up to the 1st of May of this year, amounted to 108,675,570 tons. The average quantity for the two dredgers removed every year since 1899 amounts to about 8½ million tons. The present minimum depth of the bar channel at low water of spring tides is 28ft. In the Crosby Channel the depth is now 27ft., as compared with 24ft. eight years ago.

Mr. Lyster points out the tendency to shoal in the Crosby Channel, owing to the fact that the axes of the ebb and flood currents are divergent in this channel.

Dredging has also been carried on in the convex bend on the north side of the Channel, just inside the bar channel, the material removed from here during the last twelve months amounting to over six million tons, a greater quantity than that taken from any other part of the channel. Here the concave side of the channel formed by Taylor's bank is being eroded by the centrifugal action of the current, while on the convex side the Askew Spit has advanced correspondingly. As the result of this increased curvature a reverse curve is forming lower down the river. It is here that the proposed revetment with stone, described recently in THE ENGINEER, for 2¼ miles, is to be carried out.

Having regard to the increasing size of vessels and the works that have been authorised to meet this, involving provision for a length of 1000ft., and a depth of 40ft. in draught, it has been determined to still further deepen and improve the entrance to the Mersey, and to construct a dredger of 10,000 tons capacity, and with pumping power equivalent to about three times of the existing dredger.

Two papers related to rock dredging; one by Mr. Edouard Quellennec, consulting engineer to the Suez Canal, and the other by J. W. Sandeman, the consulting engineer of Blyth Harbour. They were "Rock Dredging, with Particular Reference to Works at Blyth," and

"DREDGING ROCK IN THE SUEZ CANAL."

The rock met with in the bed of the Suez Canal consists of more or less hard calcareous or siliceous agglomerates, calcareous tufa, gypsum, and alabaster. Some of these beds are very hard. When the canal was deepened in 1884, one of their Lobnitz's rock-breaking dredgers was used, the cutting rams weighing 3½ tons. The rock removed was in layers 20in. thick, and the breaking up cost 7s. 3½d. a cubic yard. When, in 1897, it was was decided to deepen the canal to 31ft., an investigation of the method of extracting the rock by mining and explosives proved that this system could not compare in economy with rock cutters. Moreover, the experience gained with the small rams of 3½ tons and also with 5-ton rams furnished an assurance that the employment of heavier rams would solve the problem in a satisfactory manner. Besides, in the special case of the Suez Canal the use of explosives is subject to numerous inconveniences from which rock cutters on floating barges are exempt, especially with regard to the obligation of being drawn to one side for the passage of vessels. With rock cutters also the bottom is levelled off in a fairly regular manner; whereas with explosives it is necessary to remove a large quantity of rock below the intended level.

The apparatus finally selected and used consisted of two cutters of cast steel 44ft. 7½in. long, each weighing 13 tons, the cutters having renewable points of chrome steel. The fall of the ram varied between 5ft. and 10ft. The average thickness of the bed of rock shattered was 2ft. 7½in., and the number of blows required for shattering a cubic metre varied from 1 to 40, the average being 5·40 blows per cubic yard of rock broken up. The cost, including repairs and an allowance for depreciation, varied from 2·26d. to 7s. 6½d. per cubic yard, the average being 1s. 4d. Beyond this was the cost of raising the rock by dredgers and carrying it away.

Mr. J. W. Sandeman, in his note on

"ROCK DREDGING; WITH PARTICULAR REFERENCE TO THE PRESENT ROCK REMOVAL OPERATIONS AT BLYTH,"

gives particulars of the cost of dredging at Blyth with two Lobnitz rock breakers and two 700-tons hopper dredgers.

The rock at Blyth is the sandstone of the coal measures, which varies in character from friable stone, containing fire-clay, shale, and coal, to sandstone equal in hardness to basalt. Each rock breaker consists of a steel barge carrying sheer legs, from which is suspended a steel ram of 15 tons weight, 40ft. to 50ft. in length and 17in. to 19in. diameter, having a renewable conical point, tempered so as to combine a hard centre with a softer exterior, which, while wearing, enables a sharp point to be preserved. The ram is lifted by a wire rope wound upon a loose drum driven by a friction clutch. It is allowed to fall from a height of 8ft., and on an average of eight to nine blows penetrates the rock to a depth of 3ft., which is sufficient to allow of its being dredged to a depth of 2ft. 6in. The average quantity of rock which one machine has broken per week, working night and day, and allowing for all stoppages, is 908 cubic yards, at a cost of 8·8d. per cubic yard. This is based on six months' working, but as it is necessary to allow for renewal of rams, the following is the actual cost per week of wages, coal, stores, and water, and the estimated cost of repairs, full allowance being made for renewal of rams and all contingencies :—

| | £ | s. | d. |
|---|---|---|---|
| Wages ... ... ... ... ... ... ... ... ... ... ... | 16 | 1 | 6 |
| Coals, stores, and water ... ... ... ... ... ... ... | 6 | 10 | 7 |
| Estimated cost of repairs, renewal of rams, ropes, &c.... | 22 | 0 | 0 |
| Insurance at 30s. per cent. = £102 per annum ... ... | 1 | 19 | 2 |
| 908 cubic yards at 12·3d. = | £46 | 11 | 3 |

The cost of one rock breaker is about £6800, and if 4 per cent. be allowed for interest, and 2½ per cent. for depreciation—the machine being well maintained—the additional cost per cubic yard would be 2·2d., making a total cost of about 14·5d. per cubic yard.

As compared with blasting, the rock breaker disintegrates and breaks the rock into smaller pieces, so that the quantity lifted by the dredgers in a given time is about 15 per cent. more than that of blasted rock. The comparative cost of rock removal under the two systems of breaking and blasting is as follows :—

| | Per cubic yard. s. | d. |
|---|---|---|
| Drilling and blasting rock ... ... ... ... | 3 | 0 |
| Dredging same, 2s. 6d. + 8·2d.... ... ... | 3 | 2·2 |
| | 6 | 2·2 |
| Breaking rock by rock breaker ... ... ... | 1 | 2·5 |
| Dredging same, 2s. 2d. + 7·1d. ... ... | 2 | 9·1 |
| | 3 | 11·6 |

Difference in cost per cubic yard in favour of the removal of rock by means of rock breaker = 2s. 2·6d.
Saving on 500,000 cubic yards = £54,166.

Mr. L. F. Vernon-Harcourt, in opening the discussion, advocated the extension of the Mersey revetment in a southerly direction as necessary to prevent the erosion of the bank at its inner end. In reference to the rock-dredging in the Suez Canal he pointed out that the strata varied considerably, and for the most part was limestone and conglomerate, the former being the harder. He said it was proposed ultimately to dredge the canal to a uniform depth of 34½ft.

Mr. W. H. Wheeler referred to a paper he had read on the subject of dredging sandy estuaries at the Brussels International Navigation Congress about ten years ago. In that paper he has laid down the principle that channels dredged in sandy estuaries would remain permanent if so aligned that the flood and ebb currents were made to harmonise. He considered that the same principle applies to the Mersey, and that the proposed revetment would not be necessary if the channel were so dredged that a regular and even curve was maintained on the concave side of the banks in the Crosby and Queen's channels, clearing away the lower end of Taylor's bank so as to admit the flood tide directly into the lower end of the curve instead of along the reverse curve through which it now entered, and removing some projections that existed on the east side above the Formby channel. This would, he considered, remove the divergence between the axes of the flood and ebb currents which now existed. He held that if the revetment were constructed as now proposed, and not coincident with the true curve he had indicated, it would tend to increase the evils now existing.

Mr. W. H. Hunter, the Chief Engineer of the Manchester Ship Canal, regarded the proposal to construct a revetment in the Mersey 2½ miles in length as an instalment only of four or five miles which would ultimately be found necessary. He seriously suggested the readjustment of the outer end of the dredged channel over the bar, moving it more to the southward in order to avoid the re-entrant angle at the western extremity of the Taylor's Spit. He quite agreed with Mr. Lyster that something must be done to arrest the dangerous movement of the channel. Referring to Mr. Sandeman's work at Blyth, he thought that the removal of rock was costing too much money. On the Manchester Ship Canal and in the Suez Canal the rock breaking and dredging operations were being constantly interfered with by the necessity of drawing out to permit the passage of vessels, while at Blyth this was not the case, and the cost of the work should therefore be cheaper at that port. On the Manchester Ship Canal they were increasing the ruling depth from 26ft. to 28ft., and this involved the cutting, to a depth of 2ft. for a length of 14 miles, of Triassic and Permian sandstones of varying hardness, but including some very hard siliferous marls in places.

He gave particulars of cost for the month of April, the last for which he had figures:—17,400 cubic yards of rock had been removed, of which 17,060 cubic yards were broken by the Lobnitz rock-cutters. The actual costs were as follows:—Breaking, 5·39d. per cubic yard, excluding cost of plant, but including maintenance and repairs; dredging, 5·44d.; bargeing and tipping, 6·78d.; towage, 2·69d.; total, 1s. 8·3d. Adding 2d. per cubic yard for interest on cost of plant and depreciation, the total cost was a little over 1s. 10½d. Up to the present time 280,000 cubic yards of rock had been removed at an average cost of 5·9d. per yard for breaking, or under 8d. per yard including plant and depreciation. The rock excavation was measured *in situ* at 2ft. thick, although the points of the chisel rams penetrated to 4ft. below the 26ft. level. Mr. Sandeman's figure for rock-breaking was 1s. 2½d. per cubic yard.

After some remarks on rock-breaking and dredging plants by M. Bunau-Varilla, who advocated the use of larger and heavier cutting chisels, Mr. Lobnitz mentioned that the data received from various parts of the world, where rock-breakers made by his firm were in use, confirmed what Mr. Hunter had said as to the cost of such operations. Rock previously broken by the chisel could be dredged by ordinary bucket dredgers at the rate of one ton per hour per indicated horse-power of the dredger machinery.

Mr. C. Colson, C.B., considered that rock-breakers are not altogether satisfactory working in soft rock; in rock of medium hardness, more especially if bedded, the Lobnitz breaker did excellent work, and afforded the best means of removal. In hard rock, such as granite, high explosives still held the first place, and were much more economical than any other means of removal. In reference to the question of sand-pump dredging, he found that at Simonstown only 25 per cent. of the total volume pumped, when working in medium sand, consisted of solid matter. The water flowing overboard contained about 7 per cent. of solids. Thus the effective proportion of solids remaining in the barge to volume pumped was between 16 and 17 per cent.

Mr. C. H. Colson said that rock cutters were very suitable for positions where blasting was not practicable, such as in busy waterways, in proximity to buildings or other works, and in places where it was not possible to use large charges of explosives. There was also the great advantage of avoiding stoppages and removal of plant for the purpose of firing charges. But even for moderately soft rock in places where one could fire very large charges over large areas, high explosives held their own, and were to be preferred.

Mr. W. T. Douglass said that experiments were now being carried out in dredging the Eastern Gut Bar of the "James and Mary" shoal in the river Hugli by the Calcutta Port Trust's new suction dredger the Sandpiper, which has been designed by Mr. Lyster, and has now had over three months' work in the river, under the direction of the Deputy Conservator, Captain Petley. In the early months of the year the bar shoals very rapidly. The dredger worked nineteen days in March and twenty-three days in April, the last month for which he had data. The *modus operandi* is to pump sand during a portion of the rapid ebb tide, the pumped material being allowed to flow overboard. It was hoped that the rapid ebb current would carry away the sand in suspension. During the two months' work dredging was confined to the tracks Nos. 2 and 3, No. 1 track being untouched. Shoaling in No. 1 track took place to the extent of 6ft. between January 1st and April 30th, increasing by about equal amounts each month. No. 2 track shoaled 4ft. before dredging commenced, since when the depth had been increased by 6in. on April 30th, and was at times much greater. No. 3 track shoaled 4ft. in January and February, but by April 30th, after two months' dredging, it had gained 1ft. 6in. in depth.

Mr. J. W. Sandeman agreed with Mr. Hunter that in the future it would be found necessary to extend the Taylor's Bank revetment, but he considered Mr. Lyster had adopted the right position.

Mr. Lyster, in reply to the discussion, pointed out that the encroachment of the westerly end of Taylor's spit upon the channel equals the recession of the bank further up abreast the Askew spit. This tended to prove that the former was the natural outcome of the latter, and the sinuosity of the channel was to be expected when a rapid current, such as existed in the Mersey, was permitted to cut out the concave bank on the curve. By preventing the further erosion of the Taylor's bank they would at the same time check the further encroachment of the Taylor's spit in the channel, and, furthermore, be able to dredge away the projection of the Askew spit and maintain it in proper position. It was hopeless to attempt the latter while the erosion on the opposite bank was in progress. Careful comparison of surveys at different dates showed that the erosion of the Taylor's bank and the encroachment of the Askew spit opposite were equal in magnitude. This indicated a transposition of material from one to the other. He considered the construction of the revetment a necessity, and he did not agree with those speakers who held that it would be necessary to greatly extend the revetment in the future. It would probably be desirable to form a return end at the south-eastern end of the bank, where the Formby channel commenced, but further up the material forming the banks was fairly hard and not subject to erosion. As to the remarks of Mr. Hunter, Mr. Vernon-Harcourt, and Mr. Wheeler, he quite agreed that the lines they had sketched as desirable for the course of the channel might be theoretically the best, but he had had to deal with Nature as he had found her. Nature had formed a channel for herself, and he had endeavoured by means of the dredging already carried out to assist her in her labour of keeping the natural channel open and to supplement her work by deepening an already existing waterway. To have attempted to dredge entirely new cuts through the banks would have been a stupendous task and one the results of which could not be gauged beforehand.

Mr. Sandeman, replying to the discussion on his paper, said that it was impossible to make a satisfactory comparison of costs of dredging at different places when the conditions might not be similar.

Sir William Matthews, who was in the chair, in closing the discussion, said he did not share the fears expressed by Mr. Wheeler in reference to the Mersey revetment. He had been called upon to advise the Mersey Conservancy in connection with this proposal, and he considered the revetment the right thing to meet the necessities of the situation. If some such work were not carried out the Crosby channel would, in time, cut through the Taylor's bank from north to south, and they would have two poor channels instead of one good one.

The proceedings of the section then terminated with the customary votes of thanks to the Chairman, authors of papers, and the honorary secretaries.

SECTION III.—MACHINERY.

On Thursday morning this section met for the second time in the Surveyors' Institution and discussed three papers. The attendance was at first meagre, but improved slightly as the morning advanced.

The first two papers were taken together. The first was by Dr. J. T. Nicolson, and was entitled:—

"MACHINE TOOL DESIGN AS AFFECTED BY THE USE OF HIGH-SPEED CUTTING TOOLS."

The design of the lathe, the most important of all machine tools, has, says the author, been greatly modified by the introduction of the high-heat steels. Much greater power, strength, and rigidity are now necessary, and many faults of construction always existing have been laid bare by the severe tests imposed by the use of the new steel. The power required depends upon the area of the cut, the force upon the tool and the speed with which the cut is taken.

In the comparisons which follow a cut having a depth equal to one-fortieth of the height of centres and a traverse feed one quarter of this have been taken as the standard. This result is based on data collected from practice.

With regard to the second factor, it is now known that the vertical pressure exerted on the point of a tool of ordinary shape is 100 tons per square inch for soft steel, and about 80 tons per square inch for cast iron.

The third factor is the cutting speed. High heat steel has increased the speed about threefold for the heavy and moderate cuts, and about five to sevenfold for light cuts.

The power required is therefore from three to sevenfold as great for high as for low heat steel. Heavy cuts are more economical than light, if both are taken at their appropriate speeds, because:—1. The high-heat steel will cut a greater weight per unit of time, without damage. 2. The gross power is less per unit of weight machined.

*The highest and lowest spindle speeds and their ratio.*—These data are fundamental to the design of the fast headstock, and the following figures, rationally deduced, have been confirmed by practice:—

| Height of centres. | | 6in. | 12in. | 18in. | 26in. | 60in. | |
|---|---|---|---|---|---|---|---|
| Spindle speeds for carbon steel lathes | Greatest | 300 | 150 | 102 | 50 | 30 | Ratio. |
| | Least | 6 | 3 | 1·7 | 0·5 | 0·16 | 180 |
| Spindle speeds for high-heat steel lathes | Greatest | 600 | 300 | 200 | 100 | 60 | Ratio. |
| | Least | 60 | 10 | 4 | 1 | 0·5 | 120 |

*The belt drive.*—To enable them to transmit the great powers now required much higher belt speeds have become necessary. Speeds through the air of 2000ft. or 3000ft. per minute are now used, and unduly wide belts avoided. The efficiency of the belt drive is also improved by using large pulleys running at moderate speeds, rather than small pulleys running at very high rates of revolution.

*Spindles and their bearings.*—There seems at first to have been a tendency unduly to increase the diameters of the front bearings of spindles for high-speed lathes. The torques are, however, no greater than before, and as the power is—at all events, for all but the smaller sizes—transmitted through the face-plate, and not through the spindle, the reason for the large increases of diameter to be found in practice is not very obvious. Increased rigidity is, no doubt, required to withstand the shocks, which are greater at higher speeds, but, in the author's opinion, lack of rigidity has been frequently due to elaborate and defective arrangements for adjustment in the main bearings. The adoption of solid bush bearings, without any means of adjustment whatever, but fitted with forced lubrication to prevent metal-to-metal contact at the lower speeds, and so altogether to avoid wear, appears to offer a solution of the problem which will enable spindles of smaller diameters and bearings of about half their present length to be used.

*Beds and saddles.*—The greater vibration set up at high speeds of cutting by reason of the greater liability to resonance necessitates stiffer beds than before. The time-honoured double H section of bed will ultimately have to be abandoned, and a bed of box or circular section substituted for it. The discrepancy between the strengths of the old-fashioned and the proposed sections, whether for resisting, bending, or torsion, is so great as to render the retention of the old design simply a ludicrous adherence to preconceived notions. Saddles have probably always been rather wabbly, but the high-heat steel has effectually laid bare their weaknesses.

The second paper was by Mr. Darbyshire. It deals with

"PRECISION GRINDING,"

and the author says:—"In this note I propose to deal briefly with the finishing of detail parts of machinery by means of abrasive wheels, both as regards precision of dimension and quality of surface finish. Speaking comparatively, the gratifying advantages that may be obtained from the use of high-speed steel are limited to a certain point, that point being where a fractional quantity of material must be left and extreme care exercised in arriving at the precise dimensions. For this final finishing I claim that the grinding machine is the most rapid and economical tool to use, for the following reasons:—It removes this fractional amount of material in the shortest comparative time; it arrives at the desired dimensions by a series of rapid and minute chips, which cover the whole surface repeatedly and whose depth is under perfect control; any variation in its shower of sparks is instant and visible evidence of its change of form either through distortion or accident; and finally, it allows of the actual surface finishing being the last operation, thereby removing all those errors and distortions which are a result of keywaying or other reductions." Mr. Darbyshire finds the leaving of a grinding allowance of 0·015in. to 0·030in. on a diameter to be the most economical for general work in a modern machine. These broad limits allow the previous machineman to use coarse feeds and work rapidly. Where accurate results are necessary, the following points must receive attention. The first in importance is that there must be an abundant supply of water delivered at the grinding point to ensure the work being kept at an equable temperature. Hard bonded wheels should be avoided, as they do not cut freely, and may well be compared to a dull milling cutter; they are mostly chosen through mistaken ideas of economy, but a little reasoning will prove the fallacy of this.

A grinding wheel may well be likened to a milling cutter, the bond of the wheel being, as it were, the spaces between the cutting teeth. While we are grinding we must be making spaces between these cutting teeth automatically, *i.e.*, the bond must be friable enough to crumble away and allow the grit to penetrate the work to its maximum cutting depth. The degree of this friability of grade of the wheel has some relation to the texture and shape of material worked upon, and is governed by certain and easily understood laws.

The great advance that has been made in grinding practice recently has been mostly in work of cylindrical form, and for this purpose its claims to attention are undeniable. Personally Mr. Darbyshire sees no reason why the same advantages cannot be obtained in the grinding of plane surfaces with a suitably designed machine.

The discussion on these notes was opened by Mr. Hurry Riches, who spoke of the advantages he had obtained from the use of high-speed grinding; amongst these he included the great accuracy secured and the fact that the surface produced was more lasting than a turned and filed surface. Another great point in favour of grinding was that the work could be hardened before being finished. He was now trying ground axles for rolling stock.

Colonel Crompton discussed some of the difficulties that were met with in grinding. The first of these was the fact that stones of standard hardness and texture could not be obtained. One could never be sure that two different stones would produce the same effect, and it was therefore difficult to fix piece-work rates and so on. The trouble increased as higher precision was sought, and ultimately they were driven to use natural stones, which were almost prohibitively costly. Another difficulty was that to work accurately with water all over the work was almost impossible; another the expansion of the work. To take this up he recommended the use of spring centres. Finally, he enforced the extreme unwisdom of attempting to do accurate grinding in an ordinary lathe.

Mr. Whinfield criticised several points in Dr. Nicolson's paper. He did not think the author had given sufficient power in some cases. There were many lathes of 20in. centres absorbing 50 horse-power, and he knew of one with 18in. centres, fitted with a 60 horse-power motor. He also thought that the spindle speeds were too low in the table given in the paper. His firm (Armstrong, Whitworth) did not advocate now-a-days belt drive after about 10 horse-power had been reached, but where belts were used the old air speed of 1800ft. to 2000ft. per minute had been increased to 3000ft. Referring to Dr. Nicolson's remark that spindles were being made unnecessarily large, he pointed out that as they had to carry very heavy face plates and work, it was desirable that they should be big to counteract any tendency to bend. He could not see how the author's suggestion for a circular section bed would work out in practice. Touching upon Mr. Darbyshire's paper, he mentioned that in an output test on grinding black bars which he had witnessed the speed had not been reached, and the makers of the machine complained because the bars were out of truth.

Mr. R. F. Donaldson (Woolwich Arsenal) impressed upon the meeting the need of great strength and rigidity in grinding machines, but he was disposed to think that in any machine there was sufficient elasticity to take up reasonable expansion of the work without spring centres being employed.

A representative of Messrs. John Lang and Son described the lathes made by his firm.

Mr. Carnegie (Woolwich Arsenal) repeated Colonel Crompton's complaint that standard stones could not be obtained. Hard bonded wheels did not cut freely, and should be avoided.

Mr. Hall, also of the Arsenal, remarked that the stone and the material should suit each other; one stone would not do for all classes of materials. The belief that a hard stone is more economical than a soft is fallacious. It lasts longer, perhaps, but it does not do such accurate work, and time is lost by its use. Different wheels are required for wet and dry grinding. He also desired that wheels should be standardised, so that all wheels of one description bought from different makers should be the same.

Another speaker recommended that when ordering stones the class of work for which they were required should be specified. The makers would then supply that best for the purpose.

Dr. Nicolson, in replying to the discussion, urged on the makers of machine tools to approach the design in a rational way. At present they appeared to have no definite views, but met each new case as it arose. He had worked out the stresses on spindles in every possible way, and was convinced a diameter of one-third the height of centres was sufficient for any lathe. He defended his proposal for a circular bed. The present beds consisting of two girders feebly braced together by transverse bar, offered but little resistance to twisting, and really depended for their strength upon the concrete foundation to which they were bolted. He thought it would be far better to use less concrete and have a rigid bed such as could be made by adopting a closed section either circular or rectangular. He submitted that ultimately some such design would be generally adopted.

Captain Sankey here interposed the remark that a striking example of the strength of a closed section would be found in an ordinary cigar box. If the lid were open it would be found quite easy to twist the box, but if the lid were closed the two hands were not strong enough to twist it.

Mr. Darbyshire, in a brief reply to the remarks on his paper, said that he thought differences in wheels could be got over by sticking to one maker, but one wheel must not be used for all kinds of work. Even the diameter of the work must be considered. If it were of large diameter the area in contact beweeen wheel and work was great, and a soft wheel was required to get a cut; as the area of contact increased so should the softness of the wheel increase.

A note by Mr. Whitcombe on

"THE USE OF PNEUMATIC TOOLS IN WORKSHOPS"

was then read. From actual results, the author says, the following comparisons of speeds of out-turn as compared with hand work have been compiled; it is not claimed that these speeds are applicable to all classes of work, but that they can be generally attained and sometimes even exceeded:—

| Description of work. | Speeds. By hand. | By pneumatic tool. |
|---|---|---|
| Heavy chipping | 1 | 2 to 4 |
| Caulking | 1 | 3 ,, 4 |
| Drilling | 1 | 3 ,, 4 |
| Rimering | 1 | 4 ,, 6 |
| Riveting | 1 (3 men) | 1½ ,, 2½ (2 men) |

*Economical results.*—The economical results achieved, so far as piece work rates alone are concerned, are not nearly proportionate to the higher of the speeds enumerated above, but the reduced rates which have formed the subject of agreement between employers and employed enable the latter to earn higher wages in a given time, and the increased rapidity of out-turn constitutes an important item for the employers' consideration when comparing results with handwork. The following figures show approximately the reductions in piece-work rates effected by the use of pneumatic tools in the United Kingdom:—

| Description of work. | Percentage off hand-labour rates. |
|---|---|
| Chipping | 35 to 50 |
| Caulking | 35 ,, 55 |
| Drilling | 40 ,, 60 |
| Rimering | 50 ,, 75 |
| Riveting | 30 ,, 50 |

Figures recently prepared by a leading firm for their own information showed that a weekly saving of more than £2 was being effected in wages for every £1 of running cost of the pneumatic plant, the latter including interest on capital outlay, depreciation, power charges, maintenance and repairs. The number of tools owned by the firm concerned exceeds eighty, and their compressing plant has a capacity of 1500 cubic feet of free air per minute.

Reductions in piece-work rates in Germany are reported to vary as follows:—

| Description of work. | Percentage off hand-labour rates. |
|---|---|
| Chipping and caulking | 35 to 65 |
| Drilling | 50 ,, 80 |
| Riveting | 35 ,, 60 |

Mr. Hurry Riches, in the discussion, spoke of the improvement effected in pneumatic riveting by the introduction of the long stroke haromer. These hammers would do good work up to 1in., and even 1¼in. diameter, but he recommended that the rivets should be rather highly heated, and that the tips should be cooled.

Mr. Carnegie spoke of two failures of pneumatic tools for the fettling of light steel castings, and Mr. Amos urged the necessity of always putting down a compressing plant more than large enough for the immediate requirements.

Mr. Whitcombe, replying, confirmed Mr. Riches' view as to the necessity of making rivets rather hot for pneumatic work, and described a new holder-up which commenced by giving a few blows till the rivet was well home, and then held up statically. He thought Mr. Carnegie would find that on heavy steel castings there would be an advantage from pneumatic fettling.

The section then adjourned till Friday morning.

SECTION IV.—MINING AND METALLURGY.

On Thursday, June 20th, the Mining and Metallurgical Section re-met at 11.30 in the Council Room of the Institution under the chairmanship of Sir Thomas Wrightson. The first paper read was by Mr. E. M. Hann on the

"ARRANGEMENT AND DESIGN OF COLLIERY SURFACE WORKS."

This was practically a summary of the paper on the mechanical equipment of collieries contributed by the author to the Institution of Mechanical Engineers last year. It described the intended arrangements of the Penalltau Colliery, at present being sunk by the Powell Duffryn Steam Coal Company. Great progress has been effected in the steam generating and using plant. Arrangements have been made to allow of all the important engines being placed alongside the boiler-house and under one roof, under the constant supervision of a competent power station foreman. The house will be 330ft. long by 70ft. wide, and will accommodate two winding engines for raising 5000 tons a day, two electric generators, two air compressors, a condensation plant, and the ventilating engine. The sorting plant is of great importance, although fairly simple. Rotary tipplers are used, discharging sideways, plain bar screen, and then a jigger to spread the large coal upon metallic bands for picking out dirt. The small coal goes to the coal-washing machinery. Owing to the nature of the coal South Wales does not provide such a field for the introduction of modern coking methods as several others; nevertheless four considerable plants are now working. The yield of by-products are, however, much lower than would be considered satisfactory in other districts. One of these plants is on the Koppers principle of regeneration, one is of the Coppée type, and two are of the Otto-Hilgenstock type. At the first mentioned, with coal yielding on the average 9000ft. of gas per ton, 50 per cent. of the gas has been found available for power production, and a gas engine of 1200 horse-power

has been installed; and, as the plant is being duplicated, another of 2400 horse-power has been ordered. Both these are to generate three-phase electricity for the supply of three collieries producing 1,600,000 tons per annum, whilst the balance of the gas is to drive a ventilator and a direct-current plant on the spot.

There was a good discussion on the paper. Mr. T. H. Bailey and Mr. W. E. Garforth asked for further information on several points. Mr. C. P. Sparks directed attention to the trying conditions of service to which electrical machinery was exposed in colliery work, and thought that if that were borne in mind in comparing the electro-motor and the steam engine, the results would be in favour of the former. Mr. Prest asked for particulars of the author's experience of the merits of various classes of boilers. He personally wondered whether the pressure customary at collieries was high enough, and whether there would be insuperable objections to using steam, say, at 300 lb. per square inch. Professor H. Louis criticised the author's heapstead arrangements on general grounds without taking into account the local conditions. He considered that the ideal arrangement would be to have a shaft sufficiently large to employ a cage with a single deck carrying several tubs, or if more than one deck were used, to bring all the tubs on to one floor. He was surprised that the plain bar screen should still be used when movable bar screens and the ingenious Coxe screen were available. He questioned, too, whether the iron band was the best picking arrangement available at the present day. He himself inclined to the circular picking table, and thought that the substitution of canvas or india-rubber for iron, which was frequently noticeable in the United States and Germany, would probably prove economical. Mr. Vaughan Hughes referred to the strong prejudice existing among mining men against electrically-driven fans. Mr. W. H. Patchell agreed with Mr. Sparks in his remarks regarding the conditions to which electrical machinery was exposed underground, and stated that such machinery could not be too strong. Mr. J. B. Simpson wished to have some details of comparative costs of colliery working with electricity and with steam. In the North of England he had calculated that the cost with steam was £9 per horse-power per annum at one colliery and £20 at others. Mr. Hann, in his reply, stated that his boilers were of the water-tube type working at a pressure of 180 lb., which was as far as it was at present advisable to go. The adoption of the plain bar screen was dictated by the existing arrangement with the workmen. He agreed in thinking that rubber belts might largely displace metallic bands. On the whole, he thought that while the first cost of electric plant might be greater than steam, experience would show that if steam plant were used the saving effected would soon be expended on subsidiary boilers. In South Wales, where the value of small coal had appreciated, the question of fuel economy was of greater importance than in other districts where small coal was of less value. For the intermittent processes, frequent in mining, the adoption of electricity was certainly conducive to economy.

The remainder of the time of the meeting was devoted to the consideration of the paper by Mr. J. E. Stead, F.R.S., on

"SEGREGATION IN STEEL."

This paper consisted of a summary of the views previously set forth by the author in papers read before the British Association and the Cleveland Institution of Engineers, and in discussions at the Iron and Steel Institute and the International Testing Congress at Brussels. He summarised the knowledge of the concentration of metalloids in steel ingots and discussed the question of the effect of segregation on the physical properties of the finished steel. In the first place, he stated that the following facts were universally accepted as true:

1. That the purer crystallites fall out of solution in advance, leaving a less pure metal liquid, and that at one stage of the gradual solidification the metal is a pasty mass consisting of the purer solid part and an impure liquid portion.
2. That from some cause or causes, some of the more impure liquid is rejected from the surface of the freezing walls in ingots. This ascends and finally lodges under the solid upper crust of the ingots, where it eventually freezes.
3. That steel which is wild after pouring into the mould is usually badly segregated.
4. That steel cast at abnormally high temperatures, or what is equivalent, very slowly cooled, favours axial segregation of the impurities.
5. That the addition of a small quantity of aluminium to liquid steel, which is practised by steel makers for the purpose of producing quietness in the mould and soundness in the steel, also reduces axial segregation, a fact admirably demonstrated by Mr. Benjamin Talbot.
6. That not only does aluminium effect the reduction of axial segregation, but, as is proved by the macrostructures of the specimens exhibited, it also almost completely removes the minor or dark spot segregations.
7. That sulphur segregates the most, whilst phosphorus is intermediate between sulphur and carbon in this respect.

From these facts he drew the following hypothetical conclusions:—

1. That as the segregate rejected from the freezing steel is specifically lighter than the liquid steel, it will, on that account, float upwards along the freezing walls of the ingot.
2. That the gases driven off from the freezing walls must accelerate the ascent of the segregate, and therefore anything which will reduce or prevent the elimination of gas must tend to check the rate at which the more impure liquid ascends.
3. That gas blow-holes, which can only form in the plastic mixture of solid pure crystallites and impure liquid, must exert considerable pressure on the pasty metal, and it seems almost certain that some of the impure liquid will be squeezed out, escape into, and join the liquid adjoining the freezing walls, and therefore, under certain conditions, the formation of blow-holes must increase axial segregation.
4. That because the segregate rises to the top of the still fluid column, there must be a central descending slow current. This current, in passing over the very slowly freezing lower part of the ingot, deposits the purer crystallites. The impurer liquid then flows horizontally to the vertical walls and ascends, but as the walls develop and grow out of the liquid facing them, solid layers must be formed richer in impurities than the average steel. In this way I explain the annular rings, or fringes, and the purer metal in the lower central axes.
5. The rings of independent dark spots are accounted for by the assumption that some of the gas in the blow-holes, after exerting its pressure, escapes, and that a portion of the impure liquid enters and more or less completely fills them. That some of the holes have been found lined with impurer metal is a fact.
6. The irregularly distributed dark spots may be due to the same cause as is suggested in the last paragraph, and also to the land-locking of the segregate between the branches of the large primary crystals.

In conclusion, Mr. Stead pointed out the difficulty in diagnosing cases of segregation. As an illustration, Sir Lowthian Bell had found rails breaking at a point where the sleepers had been sinking, the stress being greater than when the rail was horizontal. Very frequently fractures are attributed to the action of sulphur, phosphorus, or manganese when really they are due solely to bad laying.

The discussion was opened by Mr. George Ritchie, who agreed with the author in thinking that the segregation was less in sound ingots than in honeycombed ones. The difficulty of securing sound ingots increases with the size of the ingot, and in illustration of his remarks he showed a photograph of a longitudinal section through the centre of a huge 20·15 ton fluid compressor ingot made at Beardmore's Parkhead Forge.

Mr. Archbutt referred to the effect of segregation in causing discrepancies in analysis. He cited the case of a piece of a rail drilled in twelve places, different analytical results being obtained in each case. Another segregated rail that came to his notice had a very pure central core, and drillings from the head, web, and foot showed that the pure core contained one-eighth of the sulphur shown in other parts of the rail. In such cases analysts are often unjustly blamed. He considered that the best method of detecting segregation was to take a sulphur print of the object examined. Mr. Stromeyer pointed out that recent physical research tended to show that a small increase of pressure increased the viscosity. The failure of boiler plates by cracking, occasionally met with, were not due to segregation. The only exception was in the case of the Livadia boiler plate in 1884. Mr. Cosmo Johns illustrated the complexity of the subject of segregation in high-grade steels by reference to the researches that he had had in progress for four years in conjunction with Colonel Vickers without having yet arrived at final conclusions. Nothing was, he thought, more misleading than slicing an ingot and judging by the machined surface. It was only when etched and polished that it would enable useful conclusions to be drawn. Mr. E. H. Saniter considered that a study of the macrostructure was more important than that of the microstructure, and thought that the process of sulphur printing should be better known, as it gave a permanent record more convenient for carrying about than half an ingot. He exhibited a remarkable sulphur print of the whole length of a large ingot showing the downward sag of the metal filling the pipe, thus confirming Professor H. M. Howe's theoretical results. He did not believe that aluminium would remove the minor segregation or "ghosts." Mr. F. W. Harbord disagreed with the author in some of his views. Provided that the temperature of casting is kept under control, segregation is not a serious matter in the case of the highest qualities of steel. Mr. C. P. Sandberg, jun., considered that, for rails, porosity was a greater danger than segregation. A spongy ingot would never give a satisfactory rail. Sir Thomas Wrightson referred to his researches on the change of volume on solidification and their bearing upon segregation. For a complete study of segregation it was necessary to deal with the question from a chemical and physical point of view. Mr. Vaughan Hughes remarked that in armour-piercing shells segregation frequently caused distortion but not fracture.

Mr. Stead replied briefly, confessing that the statement that aluminium removes the dark spot segregations, whilst regarded as an acknowledged fact by himself, was not so regarded by everybody. He felt that there was still much ignorance with regard to segregation, and that further research was necessary, which might advantageously be conducted on the lines indicated by Sir Thomas Wrightson. The proceedings then concluded with a vote of thanks to the authors of the papers.

SECTION V.—SHIPBUILDING.

On Thursday morning Section V. first of all held a joint meeting with Section IV., as already mentioned, and afterwards continued its session alone. There were three papers read at the joint meeting. The first of these was

"THE USE OF HGH-TENSILE STEEL IN COMPOUND STRUCTURES SUCH AS SHIPS, BRIDGES, &C.,"

by Mr. A. E. Seaton, who said that the first steel ship, the Annie, was built by Samuelson at Hull in 1864. In 1872 Whitworth offered steel plates of 40 tons per square inch tensile strength and 30 per cent. elongation. In 1874-5 Siemens offered 40-ton plates to the Admiralty, which were tough and good. In 1878 merchant ships were being classed which were built of iron whose utmost strength was 22 tons per square inch and elongation seldom more than 3 per cent., and warships built of iron of 23 tons strength, with 5 per cent. elongation. Steel-makers then offered a material 20 per cent. stronger, with an elongation of 20 per cent., and to bend double when cold instead of snapping after a few degrees, as the iron did. The first bridge to benefit by steel was built by Eads at St. Louis in 1874; the first wholly of steel was the Glasgow Bridge over the Missouri River in 1879.

Since 1896 high tensile steel has been successfully employed in the construction of destroyers and similar craft. In the Forth Bridge it was used only in compression; to-day there need be no hesitation to put it into tension and overcome thereby many difficulties. Recently the huge Cunard ships, with their heavy machinery, have been constructed so as to withstand the stresses of service conditions by freely using the high tensile steel of Spencer and Coleville.

"The question now is, can this material be used more generally with advantage? I think it can, in spite of its higher price and the allegations as to extra cost of working and durability. This latter can, I think, be dismissed, at least for the present." The author then went on to show how much shipowners can afford to pay, so as to have their ships built of high tensile steel, and declared that it was manifest that it will pay shipowners generally to employ high tensile steel freely in hull and boilers. The extra cost of working high tensile steel should be little or nothing, for, even if it is necessary to drill and plane, instead of punch and shear, with modern tools and special steel it can be done as cheaply. Then this steel can be handled hot or cold just as the mildest steel. The angle bars of keelsons, stringers, and other longitudinals might be of it, as also the angle bars of deep frames and other analogous stiffeners. The rivets should be of it, or of a steel whose resistance to shear is more than 20 tons, if the utmost advantage is required. Steel castings form no small part of a modern steamer. The large ones of s.s. Lusitania weighed 185 tons, of which the sternpost alone was 59·43 tons. There is room here for saving weights by using a tough high tensile steel.

The second paper was

"HIGH TENSILE STEEL FOR TORPEDO-BOAT CONSTRUCTION,"

by Mr. A. F. Yarrow, who states that he believes the destroyer Sokol, which he built in 1894 for the Russian Government, was the first vessel of this type constructed with this class of material. The name given to this special steel by Mr. James Riley, who introduced it to us, was Yolla metal—that is, Alloy spelt backwards. He believes nickel entered into its composition. Yolla metal, which was used in the hull of the Sokol, had a tensile strength of 37 tons to 44 tons per square inch, and an extension of not less than 15 per cent. in 8in. for plates of $\frac{3}{16}$in. thick and over. It is the buckling strains that have to be feared most in this class of work; that is to say, assuming a vessel supported on two waves at the ends, it is the buckling of the deck that has to be specially guarded against as most likely to cause failure. Stiffness can be secured not only by using steel of higher tensile strength, but by adopting a form other than flat, for curvature secures stiffness, more particularly if that curvature is obtained by hammering cold and not by bending hot. In dealing with thin plating it is in those parts subject to buckling strains that the greatest care has to be taken in the workmanship. In fact, it is quite impossible to make any reliable calculations as to what thickness is necessary to resist compression in thin structures, except on the assumption that the workmanship is exceptionally good. It has been the practice at times to use high-tensile steel for certain parts of the hull and mild steel for others. It was submitted this was not altogether a desirable combination, because to have in the same structure two classes of material possessing different properties, especially different amounts of elasticity and elongation, leads to the elastic limit of the one being passed before the limit of elasticity of the other is approached. "I take it," said the author, "our aim should be that all parts of the same structure should offer the maximum resistance simultaneously, and by so doing secure collectively a greater resistance to distortion than if the giving way were at varying periods. I think also the frames should be of high tensile steel, because they would be stiffer to resist distortion. With regard to the riveting of the high tensile steel plates, in the Sokol we increased the rivet area from what we adopted previously to the extent of about 50 per cent. This was arrived at by careful experiment; it was found that the high tensile steel plates would shear the rivets if there were not a very large margin beyond the usual practice in rivet area—that is, assuming mild steel rivets were used in combination with high tensile steel plates. The advantage gained by using this class of steel was considerable. I believe that the increase of speed secured by its adoption amounted in the Sokol to approximately 1 knot, for we obtained, within a very small fraction, 30 knots, which at the period was the highest speed recorded under the same conditions of trial."

Another paper on the same subject was

"THE USE OF HIGH TENSILE STEEL IN THE CONSTRUCTION OF THE MAURETANIA,"

by Edwin William de Rusett, who said that at a very early stage, when the stresses and structural strength of this vast and heavily-powered vessel were being considered, it became evident that steel of superior strength, in conjunction with hydraulic riveting, would have to be employed at certain parts to produce a structure which would combine the maximum of strength with the minimum of weight. It was then determined by the builders of the Mauretania and sister vessel Lusitania, in conjunction with the Cunard Company and the officials at the Admiralty and Lloyd's, that high tensile steel should be employed where the greatest stresses would be encountered, and also in other parts of the structure where steel of this character could be profitably employed to save weight, such steel to have the following qualifications under normal conditions:—(1) An ultimate tensile strength of 34 to 38 tons per square inch; (2) an elastic limit of not less than 20 tons per square inch; (3) elongation not less than 20 per cent. in 8in. In addition it should satisfactorily stand certain physical tests. For plates $\frac{3}{4}$in. thick and less, it was found that high carbon steel fulfilled these conditions, but for greater thicknesses silicon steel, supplied by Messrs. J. Spencer and Sons, Newburn, was preferred, as the high carbon steel of 34 to 38 tons tensile strength proved slightly defective in the elastic limit. During mechanical tests made by Lloyd's of the pieces of high carbon steel in which a single rivet hole had been made, it was observed that to punch the hole $\frac{1}{8}$in. small and rimer it out to full size reduced the strength of the sample less than if the hole had been drilled the full size. It would be interesting to learn from those present if, in their experience, similar mechanical tests have given

similar results, or whether those referred to were peculiar. At all events, we consider we were quite warranted in the face of such evidence in punching the high tensile steel plates up to ½in. in thickness with holes ⅛in. less in diameter, then rimering them out to the full diameter required by the rivet. By punching the holes small and rimering them as described, the saving in labour was about 10s. per plate, or about 30 per cent. less than electric drilling. All the holes in high tensile steel above ½in. in thickness were drilled, and the rag of the hole was removed by a special tool, which at the same time removed the sharp edge of the hole and produced the requisite taper for the neck of the rivet. High carbon steel was adopted in all the main transverse and longitudinal bulkheads extending to the upper deck. The lower portions of these are $\frac{19}{20}$in. thick, thence $\frac{9}{20}$in. to lower deck, $\frac{7}{20}$in. to the main deck, and above this they are $\frac{5}{20}$in. The stiffening bars are of ordinary mild steel of channel or angle sections. Silicon steel was used for parts of the top sides and doublings, also for the stringers, decks, and doublings on the shelter deck for the full width between the ship's side and casings, and stringer and adjoining strake on upper deck for a width of 8ft. 6in., and for a length of about 500ft. amidships on the shelter deck, and about 480ft. on the upper deck, tapering off at the ends. The remainder of the plating to the sides of the casings on the upper deck is of high tensile carbon steel extending for 400ft. in length. By the employment of high tensile steel a reduction of 10 per cent. on the basis of scantlings of mild steel was allowed, and a corresponding reduction in the thickness of the bulkheads where made of this material. The result has been a saving in weight of about 200 tons with an appreciable increase of strength in the top structure. The silicon and high carbon steel were not annealed. The edges of seams and butts were planed. The author also pointed out how, in his opinion, a reduction of a further 10 per cent.—making 20 per cent. in all—might have been made in these vessels. The authorities at Lloyd's Registry, from their experience up to date, strongly recommended that the rivets used for the whole structure, including the silicon and high carbon steel, should be made of mild ingot steel, consequently this material was adopted, special provision being made to minimise the shearing effect on them by rounding the edges of the drilled holes by a special tool, which was also coned to suit the taper neck of the rivet.

These three papers were read together.

There was a prolonged discussion on them, which was preceded by a few words from Mr. Seaton, who added to what he had said in his paper that he thought it was probable that in future high tensile rivets would be used with high tensile steel.

Sir William White then opened the discussion. He began with a short historical sketch of the introduction of high tensile steel into Admiralty ships, and then discussed the conditions which, in his opinion, should be laid down in connection with the use of such steel. There should, he thought, be thorough testing of the material in the makers' works, and the shipbuilders should ensure proper treatment of the material in their shipyards. Holes should be drilled in it, or if punched reamered to remove the effects of punching. He did not share Mr. Yarrow's opinion that it is desirable to use only high tensile steel in ship construction. Such a course had advantages, but when cost was considered he found it desirable—as they had done in the Mauretania—to make certain parts of mild steel and certain parts of a stronger steel. He agreed with Mr. Seaton on the desirability of using rivets of equivalent quality to the plates, and mentioned that the Admiralty practice is distinctly in favour of high tensile steel rivets.

Sir Philip Watts gave some results that had recently been obtained by Admiralty tests of high tensile—destroyer—steel. The modulus of elasticity, the tensile strength, the ultimate strength, and the elongation were as given by Mr. Yarrow. The modulus was the same as mild steel, but the elastic limit was reached at about 21½ tons. Galvanising increased it slightly. It was found that drilled rivet holes reduced the strength of a plate by 1¼ per cent., and punched holes about 9 per cent. Punching and counter-sinking reduced the strength 4 per cent., but if the holes were punched, reamered, and countersunk, there was little reduction in the strength of the plate. Comparative tests of high tensile plates, connected by iron and by high tensile rivets, showed that ½in. iron rivets worked cold in single shear have a shearing strength of 3·6 tons compared with 6·6 in the case of high tensile steel worked cold, and 9·6 in case of the same steel worked hot. For double shear the same figures are 6·6, 13·1, and 18·4. The experiments showed that the bearing pressure with high tensile steel rivets did not exceed 60 lb. per square inch. He agreed with Sir William White that mild steel and high tensile steel might be used in combination. Mild steel might be worked near the neutral axis, and high tensile steel and parts more remote from it.

Mr. D. Colville spoke of the care that had been taken by Lloyd's and the Board of Trade to test the steel made by his firm for the Lusitania. He mentioned also that they have been able to produce a steel which has a laminar structure almost resembling wrought iron.

Mr. George Ritchie said that in papers by Mr. Riley and Mr. Beardmore written in 1889 and 1896 particulars were given of tests obtained from nickel steel, and suggestions made as to the advantages arising from the use of a higher tensile steel, but with the exception of the Admiralty, and now the builders of the Cunarders, little use had been made of the stronger material available. When it could be shown how thoroughly satisfactory this higher tensile material was, and that the cost did not bear such a great disproportion to the advantage gained, it did appear strange that its use should have been so limited. Of course, increased cost of material, plates, bars, rivets, &c., increased cost of labour involved in drilling, and the possible demand for higher rates by workmen, had been stumbling-blocks in the way of the extended use of high tensile steel. Then uncertainty as to its working qualities with regard to flanging, bending, heating, &c., had caused the use of this material to be restricted to those parts of the structure where little or no curvature exists. It was certainly true that greater care must be used in the working of the stronger steel, but this applied to mild steel on its introduction, and the increase in care required now was by no means so great as was necessary when mild steel replaced iron. There was also the dubiety as to the amount of reduction in scantling which the registration societies would allow, and the extent to which they were prepared to recommend its use. As to this latter, however, his experience did not lead to any apprehension. Railway tires and axles furnished good examples of the use of high tensile steel where failure might prove as disastrous as in naval architecture, and yet steel of 55 tons tensile was in daily use in express passenger locomotives. So long ago as February, 1896, his firm made, at Parkhead, the boiler plates for the Kaiser Wilhelm der Grosse to a specification of 34-38 tons tensile, with elongation of 20 per cent. in 8in., under the survey of the Germanischer Lloyd. The dimensions of these plates were 26ft. by 8ft. by 1½in. In the same year the firm made the nickel steel boiler plates for a twin-screw tug steamer for the Cape. These plates were 17ft. by 10ft. by $1\frac{1}{16}$in., and the test results were 36 tons tensile, with 23 per cent. elongation in 8in. Mr. Ritchie also quoted some other instance where high tensile steel had been used. Of course, he said, it would be idle to ignore the fact that difficulties have been experienced in the past with higher tensile carbon steel. Plates have fractured, rivet heads snapped off, &c, &c., and in some minds there was a nervous feeling as to its use, but increased knowledge and improved methods of manufacture have overcome most of these difficulties, and by means of the *trefilage* process the danger from segregation and the defects of various kinds common to steel had been almost entirely eliminated. He gave several examples of high tensile steel being used for boilers and ships. The boilers of Mr. Beardmore's yacht, the Zaza, is made of nickel steel of 36 tons tensile strength, and the shell plating and engine forgings are of nickel steel of the same quality. So satisfactory has this yacht been that a much larger boat was built in 1905 with similar material. They had also made at Dalmuir a boiler with plates of 40-ton nickel steel, and had flanged the drums for it without difficulty. He saw no reason why naval architects should hesitate to use such material. With regard to corrosion, he was able to say from tests his firm had made that mild steel corroded 30 per cent. faster than 3 per cent. nickel steel. Dealing with Mr. de Rusett's paper, he said that he could quite confirm what he says with regard to the elastic limit of high carbon steel being less than that of silicon steel. Our experience all goes to show that this is the case; indeed, one feature of silicon steel is its high elastic limit. He was of opinion that, by the introduction of silicon into mild carbon steel, we can obtain what appears to be an ideal steel for boiler shell plates on account of its toughness and high elastic limit. Regarding the use of mild steel rivets for high tensile steel plates, it is to be regretted that it has been found necessary to use mild steel rivets in the Cunarders. There does not seem to be any reason, judging by the Admiralty experience, why rivets of a strength approximating to that of the plates should not be used. His firm have made rivets of silicon steel to 40 tons tensile, which in all respects have proved satisfactory. The shearing stress of these rivets is from 35-37 tons per square inch. Steel makers welcomed anything which would reduce the weight and thickness of plates, and he really believed that in silicon steel they had the coming metal for boiler and ship plating. His experience went to show that for every case of failure due to steel ninety-nine were due to wrong treatment in the shipyard. High tensile steel certainly needs a little more care than mild steel, but if it were taken, he, as a steel maker, had no fear for the stronger material.

Mr. S. J. P. Thearle said that the use of steel was not adopted grudgingly by Lloyd's Registry; it was cautiously accepted. It was not tensile stresses which most affect a ship. He had found vessels which showed no other signs o disturbance except buckling in the upper works. He spoke only of cargo steamers. The buckling took place amidships in situations where there was a discontinuity in the longitudinal stiffening. Thickness of material had greater value in resisting this tendency to buckle than higher tensile material itself. The iron ship he had found to be better in this respect than the steel ship. He attributed this to the fact that where iron was used it was generally thicker than steel used for the same purpose would have been. In using high tensile steels we should be careful to employ it in the proper place and way. In the large Cunarders one would not expect much compression, but chiefly tensile stresses. Buckling causes would be very slight. Hence he did not think the high tensile steel was properly employed in the plating. He would be pleased to see this material employed in rivets as well as for plates, but a great many improvements would have to be made in the rivet boy before he could be trusted with the heating of this class of material. Steel tends to burn much more readily than iron, and large areas of rivets had sometimes to be condemned because the metal had been burnt. The rivet hearth should be improved and the boy dispensed with. In his opinion sheared rivets were very rare. He thought they were well advised in using soft ingot steel in the Lusitania and Mauretania.

Professor Barr first of all discussed the figures put down in the table for the modulus. He thought they were misleading. The modulus of elasticity did not alter over different amounts of loads, though the figures in the table appeared to make the quantity vary very greatly. He gave examples of what he meant. The determination of the elastic limit, he continued, was an exceedingly indefinite thing unless it was very clearly defined what was meant. Did it mean the outside yielding point or the supposed elastic limit below that? They had no results of high tensile steel tested by alternate stresses.

Mr. C. H. Wingfield thought it was a good sign that great stress had been laid, not only upon the ultimate stress, but on the elastic limit. As regarded contraction in area, he thought that in some cases it was a distinct disadvantage to have this large. He would like to ask Mr. Yarrow if he got the enlargement of area he had mentioned by increasing the number of rivets or increasing the diameter.

Professor Biles asked if there was any information on the subject of permanent set due to stresses. Continuing, he said that he did not quite understand what was meant by stiffness, at least in a scientific sense. There was some difference between the recorded results of experiments with mild steel and with ordinary wrought iron in the bending test. The Destroyer Committee had come to the conclusion that there was nothing trustworthy in the way of experiments to determine accurately the crushing limits or the liability to crush of any compound constructed. All that could be done was to make deductions and to allow ample margin. The Admiralty practice in destroyers was to have decks with stiffened undersides. This was the only way to get over the "crushing" difficulty.

Mr. F. E. Robertson suggested that it would be more correct to confine specifications to the elastic strength only. What had engineers to do with ultimate strength? A manufacturer, he thought, should be allowed to give anything he pleased as long as he gave the required elongation.

Mr. F. W. Harbord said it had long been a mystery to him why the higher tensile steel was not used for bridge work. He thought there ought to be no excessive cost over mild steel, though the harder steel costs a little more to roll. He called attention to an electrical furnace used for the tempering of tools, and suggested it might be used for the heating of rivets.

Mr. D. M. Maclay gave some information regarding the results of some of the tests carried out by the Board of Trade and Lloyd's. These were of considerable interest, but lack of space prevents our referring to them at length.

Mr. J. Brughn, after some remarks regarding the reduction in scantlings as suggested by Mr. De Rusett, said that he thoroughly agreed with what previous speakers had said regarding the modulus of elasticity. If the moduli are the same the stresses would be the same.

Mr. E. W. De Rusett then replied. He said that regarding the tests of rivets, in no case did they shear. In every instance the high tensile steel specimen broke through the rivet holes. He spoke of the necessity of educating the workmen up to the use of high tensile rivets, but owing to the shortness of time reserved further remarks to be sent in in writing.

Mr. Seaton also replied very briefly, expressing his willingness to meet Professor Barr as to changes in his table. He did not agree with Mr. Thearle about the shearing of rivets. He had seen thousands of sheared rivets in various parts of ships. He spoke of the extraordinary resemblance between a sample of steel sent him by Mr. Colville and wrought iron.

A vote of thanks having been passed to the three authors, the next two papers were taken.

The fourth paper, which was taken by Section V. alone, was on

"THE STRUCTURAL DETAILS OF CARGO STEAMERS IN RELATION TO THEIR WATER BALLAST ARRANGEMENTS,"

by Mr. Samuel J. P. Thearle, who commenced by stating that water ballast was first carried in screw colliers trading between the Tyne and the Thames. The earliest steam colliers were, like the sailing colliers before them, ballasted with Thames gravel for the voyage to the Tyne, but it at length occurred to an ingenious person that water was superior to gravel as a ballasting material, because it might be made to flow into and out of a vessel instead of being carried in baskets. And so tanks were built in the bottom of the steamer, into which water was admitted for ballasting, and out of which it could be pumped when no longer required. Very soon these tanks became an integral part of the structure, and thence originated the McIntyre tank. The chief and characteristic structural feature of this tank is the bracket attachment of the frames to the flanged margin plate. A proximate step consisted in the adoption of the cellular system of double-bottom construction. Two systems of cellular double bottom are adopted, in one of which floors are spaced at every frame, and in the other at alternate frames, the side girders being much more closely spaced in the latter than in the former arrangement. The Board of Trade ultimately sanctioned the omission of the whole of the double bottom space in measuring a vessel for tonnage, and this concession gave a great impetus to the system, which at the present day is adopted in all but the smallest of cargo steamers. It was submitted for the consideration of the meeting whether the structural strength of cellular double bottoms in cargo holds was not usually somewhat in excess of actual requirements, especially under cargo holds. Vessels fitted with cellular double bottoms usually have after-peak ballast tanks for trimming purposes, and some have fore peak ballast tanks also. In each case valuable use is thereby made of a space which can be employed for but few other purposes. It has of late years been very usual to fit midship deep tanks in cargo steamers in order to obtain the necessary immersion when the vessels are in ballast trim. Such deep ballast tanks sometimes contain upwards of 1000 tons of water. Cargo is carried in these deep tanks when they are not used for water-ballasting purposes, and, consequently, there has always been a natural desire to break the stowage as little as possible inside the tank, and to make the work of getting the cargo in and out of it as simple as possible. In order to effect this the middle line longitudinal bulkhead has in some cases been omitted, and there is a growing desire to dispense with it altogether. When

deep tanks are not fitted in a steamer, and when the weight of the water carried in the after-peak tank is not sufficient, acting in conjunction with the other water ballasting, to give the necessary immersion to the screw propeller, it has been usual to supplement water with shingle or gravel ballast carried on deck and thrown overboard on entering the loading port. To save the expense of taking this shingle ballast, or of building a deep tank in the steamer, some owners have authorised the masters of their vessels to admit water into the after-hold by taking off some manhole covers from the inner bottom, and then opening the sea-cock until a sufficient quantity of water is admitted for obtaining the desired immersion of the screw propeller. Of late some very valuable arrangements, both from a structural as well as from a navigator's or a shipowner's point of view, have been introduced into cargo steamers. One of these is the Dixon and Harroway system of wing tanks for carrying water ballast, and another is known as McGlashan's side tank system. Plans have been prepared for carrying water ballast in enclosed spaces upon the upper decks of steamers between the hatchways. Other proposals have been made for carrying water in the 'tween decks confined within compartments bulkheaded off for the purpose, and made available for cargo-carrying by having hatches fitted to them. Neither of these arrangements has, however, found favour among shipowners. It will be evident that each would involve very considerable pillaring supports being placed beneath them. It was submitted that a water ballast carrying arrangement in a steamer should serve the purpose of contributing both to her structural strength and to her safety at sea. The spaces devoted to water ballast should also be of such a character that they would not be included in the tonnage measurement of the vessel except when used for carrying cargo. They should be readily and freely accessible for examination, cleaning, and re-coating, and should be so proportioned and situated that the water within them will not detract seriously from the vessel's stability while the spaces are in course of being filled or emptied, nor unduly add to the vessel's stability when full. They should further be so constructed and fitted as to minimise the stresses set up within them in the possible event of their being not quite filled when the vessel is rolling or pitching in a seaway, and they should be so situated in the vessel as not to set up undue stresses upon the structure when she is in a ballasted condition. It was further submitted that if all these requirements could be satisfied without the hull of the vessel being any heavier than would have been the case had no water ballast accommodation been provided, then, in such circumstances, an ideal arrangement would have been arrived at.

Another subject was then dealt with, namely,

"ARRANGEMENTS FOR WORKING CARGO ON SHIPS,"

which was introduced by Mr. W. H. Dugdale, who said that vessels are now designed and constructed to meet special requirements, and the exigencies of special trades, which, of course, have necessitated improved facilities being invented and introduced to deal with the various requirements, especially in dealing with cargo—namely, loading and discharging. In the old sailing-ship days this was done by means of a hand winch, which for generations has altered very little in design; but as sailing ships became larger, and the cargo of a heavier description, a donkey boiler and steam winch were fitted to deal with it. In the case of steamers, steam winches were, of course, adopted at an early date. Naturally, many important improvements have been made and various changes effected. In the early days it was found that yards and sails were unnecessary for propulsion, and they were soon dispensed with. In cases where derricks attached to masts or tables built on to the masts have not been sufficient to cope with the cargo with the necessary despatch, or have not been able to work the hatchways, additional poles have been erected, carrying derricks, and fitted with winches and the necessary gear. To such an extent has the use of derrick posts been adopted that the turret steamer Grangesberg, built in 1903 by Messrs. Wm. Doxford and Sons, for the ore trade, had no masts, and, therefore, no sails. In some steamers revolving steam cranes have been fitted, capable of plumbing the hatchways and discharging the cargo into barges alongside. Various attempts have been made to introduce different systems of discharging gear on board ship, such as hydraulic cranes, and, later, electrical winches; but the initial cost has been the principal cause which has prevented their more general adoption. The upkeep and repairs of electrical winches would probably be somewhat less than those of steam winches, but would involve the addition of an electrical engineer to the ordinary staff.

In 1885 Messrs. Wm. Doxford and Sons built the steamer Golconda, which was fitted with a very complete equipment of hydraulic machinery by Messrs. Brown Brothers and Co., of Edinburgh, which worked beautifully, and the author believed is still working in that vessel. Since then Brown Brothers have fitted upwards of ninety installations on board large passenger steamers, where comparatively noiseless working is required and first cost is not such an important factor. Of course the question of cargo appliances on board large steamers running in regular trades is not of such importance, for they have their own shore berths at each end of their passage, fitted with such necessary appliances as fixed or travelling cranes actuated by steam, electricity, or hydraulic power. Vessels regularly engaged in the coal trade have received special attention from designers and builders because their voyages are generally short. In colliers not trading to ports where good discharging facilities are available, it has been found necessary to fit special appliances on board the vessel for rapid discharge of the cargo. Messrs. S. P. Austin and Son built a collier named Harmony in 1897 for Messrs. J. and C. Harrison, carrying about 1900 tons deadweight. This vessel was fitted with Atmer's gear, which consists of an engine placed in some convenient position to actuate a shaft running fore and aft alongside the hatchways, and upon this shaft drums are fitted, working whips through gins attached to gaffs.

In 1906 Messrs. John Blumer and Company built the St. Paul, a steamer carrying about 4000 tons deadweight, for Messrs. Wilson and Company, of Gothenburg. She is fitted with Captain Sieurin's discharging gear, which consists of a particular kind of winch capable of dealing with all kinds of cargoes, including general cargoes. A scoop is used for bulk cargoes, which can travel any distance under the deck and fetch coal from all parts of the ship's holds, thus dispensing with trimming and manual labour. The author said that he might multiply the examples given, but they would be more or less modifications of the types already referred to. In fact, as necessity arises, and some special requirement presents itself, the difficulty is solved.

The discussion upon these two papers—which were taken together—was commenced by Professor Biles, who, in a jocose vein, expressed his surprise and delight at the admission Mr. Thearle had tacitly made that the scantlings of double bottoms generally adopted and required by Lloyd's Rules were in his opinion excessive. He said shipbuilders would be glad to know that Mr. Thearle was of this opinion, and they would hope that he would use his influence in getting the matter put right. He was shocked to find Mr. Thearle praising certain modes of construction because they tended to give a reduced tonnage measurement. It was but yesterday they had to listen to the complaints of dock authorities that they had not the funds for making improvements owing to their small revenues. How, then, were the poor dock owners to make both ends meet if tonnages upon which dock dues are paid were cut down. Regarding the question of double bottom wasting under boilers, Professor Biles said he would get over the difficulty by not having any double bottom, but only ordinary framing at these places. He had a great objection to the flanging of intercostal plates against floors in double bottoms, but he did not think flanging was objectionable at the upper and lower edges of intercostals. Referring to deep water ballast tanks, Professor Biles thought the middle line partition bulkheads might be dispensed with.

Mr. Weyman Dixon, who, with Mr. Harroway, has patented the wing ballast tank and cantilever frame system, spoke at some length regarding the merits of the arrangement, and said he thought the time had come when vessels so constructed might be permitted by the Board of Trade to carry grain cargoes without shifting boards.

Mr. F. J. Trewent considered that Lloyd's Rules unduly penalised the floor at alternate frame system of double bottom construction, and that in consequence many vessels were fitted with the floor-at-every-frame system which might desirably have been otherwise. He complained of the relative inaccessibility of the floor-at-every-frame arrangement, and the consequent want of attention to which the double bottom spaces were exposed on that account.

Mr. A. E. Seaton explained the scientific aspect of double bottom corrosion under boilers and the chemical theory of the phenomenon.

Sir William White and Mr. Edwards addressed their remarks chiefly to the subject of Mr. Dugdale's paper. Sir William White said that in the matter of handling cargoes the Americans on the Great Lakes were a long way ahead of us in this country; but, of course, the measures adopted for the purpose were provided on the wharfs and quays, and were not part of the outfit of the vessels.

Owing to the deep interest taken in the discussion of the three papers on high tenacity steel, the time devoted to Mr. Thearle and Mr. Dugdale's papers was necessarily brief, as also were the replies of those gentlemen.

Mr. Thearle said that as he had distinctly invited discussion he could not complain at having elicited it. He could only say that he was very glad opinions had been so fully expressed, and that his object had thereby been well served. He could not agree with all that had been said, and especially as regards the maintenance of double bottoms. He thought it undesirable to omit them in the way of boilers, and so cause a break in that element of safety which a double bottom contributes. He would fit the double bottom, and take better precautions for preventing corrosion than are often adopted. Under boilers the rapid wasting is due to the association of heat and moisture. Get rid of either and the rate of wasting became slight. He preferred to attack the moisture, and this he would do in the manner so successfully followed by Mr. Lyall of the Clan Line, who ventilated by means of air currents induced by the heat of the funnel uptake. Mr. Thearle explained to Mr. Trewent that Lloyd's Rules do not favour one mode of construction of double bottoms over another. The plan which was found the cheapest was the one a builder adopted. On the Clyde the floor at every frame is preferred, but at Sunderland most of the builders adopted the floor-at-alternate-frame system.

Mr. Dugdale briefly thanked the meeting for the kind reception it had given to his paper.

## SECTION VI.—WATERWORKS, SEWERAGE, AND GASWORKS.

The sitting of Section VI. of the conference on Thursday morning was devoted to gas supply. Unfortunately, the Institution of Gas Engineers had selected the conference week for its general meeting, which was held in Dublin, and a large number of gas engineers were thereby attracted to that city, and consequently could not take part in the proceedings of the conference. Notwithstanding the counter-attraction in Dublin, however, some sixty engineers were present in the upper library of the Institution, when Sir George Livesey, M. Inst. C.E., took the chair for the sitting of the Section on Thursday at 10.0 a.m. He offered a few opening remarks, in the course of which he referred to the unfortunate clashing of the Dublin meeting. He then proceeded to quote a statement credited to Sir W. B. Richmond to the effect that the late springs and early autumns experienced in London were due to smoke. The best means of avoiding a smoky atmosphere was the use of gas as fuel. In order to make its application for heating purposes more general, it was essential that gas should be sold cheaply; but it was difficult to sell gas cheaply. Gas undertakings were confronted with frequent booms in the coal trade, which compelled them to pay dearly for their coal, and with the burden of exceptionally high rates. Only about 1 per cent. of the price of ordinary commodities represented payment in the shape of rates, but the rates accounted for from 5 to 10 per cent. of the price paid for gas and water. Local authorities had apparently failed to understand that it was the endeavour of gas companies to sell gas at as low a price as possible, since the majority of them worked either wholly or to some extent under the provisions of a sliding scale, whereby a high price of gas meant reduced dividends to the shareholder. But even where the sliding scale was not operative, it was the endeavour of gas undertakings to keep the price of gas as low as possible. The cheapest gas supply in the country was in Sheffield, where the supplying company was only under a sliding scale to a limited extent. It was necessary to impress upon local authorities that it was to the interest of the public that gas should be cheap, and that it was bad policy to rate gas works heavily. Gas was subject to serious competition, and only that week a company had been formed with the object of carbonising three million tons of coal per annum in London for the production of a new smokeless fuel. That was more coal than the London gas companies carbonised, but there was nothing to prevent them making and selling similar fuel if there were a demand for it. The new company claimed that it could prevent the gas companies making such a fuel, and if it should attempt to enforce that claim, it would be seen whether the patents which it exploited—but which had not been published—were really worth the paper they were written on.

Sir George Livesey then called upon Mr. W. H. Y. Webber, to read his communication upon

"THE APPLICATIONS OF TOWNS GAS AS A HEATING AGENT."

The general recognition of ordinary towns gas as primarily a fuel dates only from the year 1900, when upon the initiative of the South Metropolitan Gas Company, the traditional supremacy of the illuminating-power standard of quality for this kind of combustible gas was overthrown by Parliament. The great change of technical opinion in this regard sprang from the conviction that not only had the Welsbach invention of incandescent gas-lighting come to stay, but it had also revolutionised the principles of gas-manufacture. The importance and far-reaching character of this revolution in the whole polity of the gas industry quickly asserted itself. The expensive practice of artificially enriching gas with hydrocarbons to make it show a brilliant luminous flame at the statutory testing stations fell into discredit; and quite recently Parliament liberated the industry, in London and other towns, from the bonds of a meticulous standard of purification which had always given more trouble than it was worth. The gas calorimeter is now set up in every important gasworks; and engineers have acquired the habit of talking of their product in terms of calorific value. Meanwhile, gas companies and gas committees of municipal corporations perceived the industrial prospects of gas in a new light, as a fuel and source of motive power for town workshops and factories. Producer-gas having only about one-fourth to one-fifth of the heat value of the cheapest towns gas, being of uncertain composition, and requiring 20 per cent. more cylinder-capacity for the same effective horse-power (besides being liable to cause danger to life and to create a nuisance), does not make headway against towns gas at 2s. per 1000 cubic feet. Hitherto, the cost has proved an obstacle to the general use of gas fires; but with the gas consumption reduced to 20 cubic feet per hour, the expense of occasional fires in a household does not compare unfavourably with coal, especially if additional servants' wages are considered. Hotels are being converted to the use of gas fires. There is yet plenty of room for improvement in these articles. Gas-steam radiators are the latest type of gas-heating apparatus, and are very effective. Gas-heated water circulators of recent introduction are already well received by the public, being in every respect an improvement on the usual kitchen range boiler. The modern conception of towns gas as a powerful, clean, convenient, and not prohibitively expensive fuel has already borne fruit in many forms of industrial gas furnaces. Some of these are low-pressure appliances, worked directly off the street mains; which, however, now usually carry much higher pressures than formerly. Hitherto pressure in gas distribution has meant the head necessary to transmit gas to its destination in sufficient quantity. But recent developments have imposed another function upon pressure; and if there is any new point in this note it is that in the potentiality of towns gas to attain any degree of temperature required for an industrial purpose, by increase of pressure at the burner, there lies awaiting development a new and valuable asset of the gas industry. Mr. Onslow had already gained experience of high-pressure gas for lighting, as one of the inventors of the Sale-Onslow system; and he first applied gas at the same pressure, 53in. of water, to solve the problem. It was found that a mass of metal could be heated by this means to 1040 deg. Cent. in 4½ hours for a consumption of 1700 cubic feet of gas of the ordinary 14-candle grade. By simply increasing the gas pressure to 67in. the same work was accomplished in 2½ hours with 1300 cubic feet of gas. Whereas a coal and coke furnace could only deal with four long steel bars a day, gas at 94in. pressure consuming 900 cubic feet per hour heated four bars an hour.

The discussion upon the subject of Mr. Webber's paper was opened by Mr. T. Goulden, chief engineer of the Gas

Light and Coke Company, who commenced by saying that it was important that towns gas should be recognised as primarily a heating agent. When visiting continental towns he had observed that the gas lighting was extremely good, yet the illuminating power of gas was now disregarded on the Continent. The calorific value only was considered. In one town—Dessau—he was informed that 99 per cent. of the gas sold was used as a heating agent, *i.e.*, either directly for heating purposes or for gas engines, or for heating mantles for lighting purposes. In this country gasworks were hampered through the necessity of complying with standards of illuminating power. They sent out gas with a liberal amount of illuminating constituents, yet it was apt to be found deficient when tested in the district supplied. Gas works should be at liberty to work to a calorific standard only. It was a better standard also from the point of view of a test, because calorific power could be accurately determined. The determination did not—like that of illuminating power—depend on vision. At Dessau the calorific standard worked to was 5500 calories per cubic metre gross calorific power (= 155½ calories per cubic foot).

Mr. B. H. Thwaite said that he had pointed out as early as 1892 that gas should be regarded primarily as a fuel, and that it ought not to be valued according to a standard of illuminating power. He had suggested that the pressure at which gas was supplied should be increased. The calorific value of gas could be judged approximately from its behaviour when burnt in the Welsbach burner. Since 1897 he had used only that burner. He thought Mr. Webber was not justified in speaking of producer gas as of uncertain composition. In his experience, both blast-furnace gas and suction producer gas were of more uniform calorific power than ordinary town gas.

Mr. H. A. Humphrey said he would like to see further development in the use of town's gas as a heating agent, but he thought this development need not interfere with the use of producer gas, and he was sorry that Mr. Webber had written disparagingly of such gas. As to the alleged uncertain composition of producer gas, he would point out that tests showed that the Mond gas supplied by the South Staffordshire Mond Gas Company was more uniform in calorific power than the ordinary gas supplied in the townships in the same area. Further, the statement that producer gas required 20 per cent. more cylinder capacity for the same effective horse-power was only true if a gas engine adapted for the consumption of coal gas was taken forthwith into use with producer gas. If, however, an engine designed for the consumption of producer gas were used for the latter, the cylinder capacity was not greater than that of one of the same effective horse-power consuming coal gas. With Mond gas an effective pressure of 112 lb. to 120 lb. per square inch could be obtained in the cylinder; and no higher pressure than that could be reached with coal gas. This was the best criterion of the relative value of the two gases in a gas engine. Again, it was wrong to imply that there was greater danger to life from the use of producer gas than from town's gas. The proportion of the highly poisonous constituent, carbonic oxide, was limited by law to 14 per cent. in the Mond gas distributed by the South Staffordshire Mond Gas Company, and it actually averaged about 12 per cent. This proportion was frequently exceeded in town's gas supplies. There was, he believed, room for both town's gas and producer gas supplies. Town's gas might be used with gas engines of comparatively small power, but it could not reasonably be employed where, say, 2000 horse-power was required. Then only producer or similar fuel gas could be employed, and he believed that the use of such fuel gas would rapidly extend.

Mr. Charles Hawksley said that, as a consumer having about fourteen gas fires in his house, he wished to direct attention to the necessity, not only of a good pressure in the mains, but of service pipes of ample size. Otherwise the lighting of another fire diminished the supply to those already alight, and it became impossible to get a cheerful fire. Gas companies should not disregard the quality of their gas too freely; when long ago he had used gas in flat-flame burners the sulphur products had made him cough.

Mr. C. C. Carpenter, M. Inst. C.E., chief engineer to the South Metropolitan Gas Company, said that he had frequently remarked the brilliant lighting of several German towns. He believed it was partly accounted for by the absence of dust in the air. The dust in the air of London caused trouble by choking up the incandescent burners, which required very frequent attention in consequence. It also caused gas radiators to smell. The blackening of ceilings above gas burners was also due to the dust in the air, and not to smoke from the flames. That atmospheric dust was alone responsible for such blackening could be seen from the blackened state of the walls of the library—in which they were then sitting—wherever there was a steam radiator to induce a flow of air towards the wall.

Mr. W. J. A. Butterfield, F.I.C., confirmed Mr. Goulden's statement that continental gasworks worked only to a calorific power standard. Earlier in the week he had visited the large new installation of vertical retorts at Cologne, and found that the coal gas made in them during the first eight hours or so after charging was diluted with water gas made by subsequently injecting steam into the retorts. The dilution was carried to such an extent as was consistent with the production of a mixed gas as near as might be to, but not less than, 5000 calories per cubic metre in gross calorific value—that is to say, about 141¼ calories per cubic foot—which was lower than the standard to which English engineers worked. He also pointed out that for heating operations in laboratories a high gas pressure was essential, and that chemists had until recently been unable to get it. On that account some of them had been forced to use electrical instead of gas furnaces.

Mr. W. King, M. Inst. C.E., formerly chief engineer to the Liverpool Gas Company, thought that, while it was necessary to sell cheap gas, the pipes must also be of sufficient size to afford an ample and uniform supply.

Mr. C. E. Jones said that he agreed that pipes of ample size were essential for gas supplies for heating and cooking purposes. He thought Mr. Onslow was to be heartily congratulated on the work which he had done at the Royal Arsenal, Woolwich, in applying gas at high pressure to the annealing and tempering of large masses of metal. Mr. Onslow was not under any parliamentary restriction as to the quality of the gas which he made, and was therefore at liberty to manufacture the gas which appeared to him best suited to the requirements, and to devote time to developing new methods of applying it. It would be a good thing if other gas engineers were given an equally free hand.

Some interesting details of the advantages accruing from the use of gas at high pressure for steam raising, varnish manufacture, and type melting were quoted on behalf of Mr. Goodenough, the distributing engineer to the Gas Light and Coke Company. Other speakers asked questions as to the efficiency of gas fires, the use of gas at high pressure for heating, and the nature of coalite.

Mr. W. H. Y. Webber, in his reply, said that he felt gratified at the length of the discussion. He had wished to present a longer paper, which would have dealt with many of the points raised, but he had been limited to about a thousand words. He agreed with Mr. Goulden and other speakers as to the importance of gas as a heating agent. He thought gas having a gross calorific power of 520 to 560 British thermal units—about 130 to 140 calories—per cubic foot should suffice for all purposes, but the flame temperature of the gas must be regarded also. Ordinary producer gas was not so constant in quality as coal gas, and it was on that account that coal gas was used for heating purposes at the Royal Arsenal. He understood that not only all the producers, but even the coke and coal furnaces there, were eventually to be displaced in favour of coal gas under high pressure. With the latter it had been found that, using burners placed so that the flame passed tangentially into the space between the crucible and the furnace lining, and did not immediately strike the solid material, masses of metal 3ft. and more in length could be rapidly raised to a temperature of 1000 deg. Cent. Mond gas in South Staffordshire stood on a rather different plane from ordinary producer gas, and in the manner of distribution over a large area resembled coal gas. As to the duty of gas fires, it was difficult to speak precisely, but he had found from 27 to 28 per cent. of the total heating value of the gas consumed given out as radiant heat only. The warming effect from the "black" heat could be readily increased in most cases. The smell from Bunsen burners used for heating was generally due to the inner cone of the flame being brought in contact with a solid material, whereas the latter ought not to dip below the outer cone of the flame. In many gas fires there was a slight escape of products of combustion into the air of the room, and this gave the impression of dryness. There was no doubt that a gas fire in the ordinary grate was pleasanter than one of the independent gas stoves standing out in front of the fireplace. The dust of London air was very troublesome in gas burners.

Mr. C. C. Carpenter then read his communication on

"THE DISTRIBUTION OF GAS AT INCREASED PRESSURE,"

in which the introduction and use of his non-positive type of fan or blower are discussed.

The discussion on this subject was opened by Mr. A. J. Martin, who drew attention to the fact that, notwithstanding high distributing pressure, the leakage, comprised in the unaccounted for gas, continued low. He had learnt by inquiry that at Aurora, Illinois, where a distributing pressure of 15 lb. per square inch had been used—it was being increased to 50 lb.—there had been no trouble from excessive leakage. With higher pressures of distribution it seemed likely that small gasworks would disappear, and the supply be taken over by the larger works some distance away, which had better facilities for obtaining cheap coal. Regarding a gas distributing system as a power distributor from a central source, he would go farther than Mr. Carpenter, and say that it was cheaper than an electricity distributing system. The weight of copper required to convey a certain power electrically was greater than the weight of the steel mains required to convey the same power the same distance by gas at high pressure. The relative prices of copper and steel made the comparison very favourable to gas. Further, it must be remembered that the cost of the copper was doubled or trebled by the cost of insulation. The loss of current in transmission was 10 to 20 per cent. against 2 to 3 per cent. loss with gas; 4in. gas pipes at 60 lb. pressure would serve to convey gas equivalent to the 4000 kilowatts which the London County Council's electricity supply scheme had proposed to send on the average from Greenwich to each of twenty-nine sub-stations. The cost of the cables and ducts had been estimated at £666,000; the 4in. gas pipes would cost only £43,000, and would transmit the same power. The cost of the coal used by the London Electricity Supply Companies was often greater than the cost of the equivalent quantity of coal gas—at the price now charged by the South Metropolitan Gas Company. The gas companies should be freed from all restrictions, so that they might have a free hand to supply that gas which they found most suitable for their customers.

Mr. W. J. Dibdin, F.I.C., thought the use of gas at high pressure a great advantage for heating purposes in laboratories.

Mr. T. S. Lacey, of the Gas Light and Coke Company, said that from the first it had been necessary to pump gas from Beckton to London, as the holder pressure was quite inadequate when the distance to be traversed was so great (10 to 12 miles). At the stations in London there were pumps for taking the gas from, or putting it into, the 48in. high-pressure mains, according to the immediate requirements. A higher distributing pressure would be a great advantage to users of the incandescent burner.

Mr. A. Auden said that he had found gas at high pressure very good for lighting purposes in a factory, but troublesome for keeping type-metal melted, and he had eventually put in a low-pressure service again for the latter purpose.

Mr. J. L. Chapman, engineer of the Harrow Gas Company, said that he had found it advantageous to give all consumers a pressure of 3in. in the daytime.

Mr. W. King reported that he had found it necessary to introduce high-pressure distribution at Liverpool as early as 1878, and by degrees they reached a pressure of 40in. to 45in. They had used Beale's exhausters for pumping. For the pipes he used entirely bored and turned joints, as introduced in Liverpool in 1826 by his father.

Mr. Dolby having mentioned an instance of an explosion due to gas escaping from a water-slide pendant in a consumer's house, when it was supposed that the distributing pressure had been increased in order to fill balloons with gas, Sir George Livesey said that the South Metropolitan Gas Company was altering all water-slide fittings in its district in order to make them safe. Pressure could not be increased to any considerable extent while these fittings remained in use. Then, again, the meters needed some adaptation for use with the higher pressures. It was essential, however, that the consumer should get a higher pressure. Strangely enough, the time at which the South Metropolitan Gas Company found it most difficult to maintain adequate pressure in the mains was between 11 and 12 o'clock on Sunday mornings, when so many dinners were being cooked.

Mr. Carpenter said that Sir George Livesey had already answered for him some of the points raised in the discussion. The amount of gas sent out by his company was at a maximum equivalent to about 500,000 horse-power per hour if used in gas engines. The chicken incubator was an illustration of the practicability of maintaining a uniform temperature by regulation of a gas flame.

The proceedings then closed with votes of thanks to the authors of the two communications.

## SECTION VII.—APPLICATIONS OF ELECTRICITY.

This section met on Wednesday morning at 10.30 in the Council-room. The first paper taken was entitled

"ELECTRICAL TRANSMISSION GEARS ON MOTOR VEHICLES,"

and was by Mr. A. A. Campbell Swinton. The author says that in view of the somewhat barbarous method of gear changing at present in vogue on most petrol-driven motor vehicles, and of the fact that, crude as it is, this method continues to hold its own against all other mechanical devices, it is not surprising that attention has been turned to electrical arrangements for arriving at what is required, especially in the case of the heavier description of vehicles. He points out that several arrangements of electrical transmission have been adopted. In one case, the engine drives a dynamo which supplies energy to an electric motor, which in turn drives the road wheels through the usual mechanical differential gear. A second case was similar to the foregoing, excepting that the axes of the dynamo and motor being arranged in line, a clutch of some description is arranged between them, so that at top speed they can be mechanically connected together and electrical driving and all consequent losses dispensed with, the armatures of dynamo and motor acting merely as fly-wheels. Then, in a third case, an engine drives a dynamo as in the previous examples, but instead of one motor two or more are employed, each driving a separate wheel. The mechanical differential is thus dispensed with, but the direct drive, as in the second example, cannot be arranged for. The two or more motors can either be arranged in the hubs of the wheels, when all gearing is dispensed with, or can drive the wheels through chain or toothed-wheel reduction gear. Then, again, a storage battery of comparatively small capacity, but capable of giving large discharges for short intervals, can be employed with any of the above-mentioned systems, the arrangement being such that for starting, or on hills, the battery discharges and assists the engine and dynamo in driving the motors, while at other times a part of the power of the engine is absorbed in charging the battery. In another method it was explained a storage battery is used to assist the engine when required. There are no separate dynamo and motors, but on the shaft of a mechanical transmission is fixed the armature of a machine which performs the functions of both dynamo and motor as required. These systems with auxiliary batteries possess the advantage that, as the battery affords a ready means of starting the engine, the latter can always be stopped when the vehicle is at rest. The chief scope for electrical transmission on motor vehicles seems to be on heavy vehicles such as motor omnibuses, lorries, and the like, and especially on large motor coaches on rails, such as several of the railway companies are now running on suburban lines. Though considerable success has already been attained with the electrical system of transmission in its various forms, there is obviously still much room for development and improvement.

In the discussion which followed Mr. E. W. Hart said that four or five years ago he experienced considerable trouble with continuous-current machines. Afterwards he experimented with polyphase motors, and had finally overcome the speed regulation difficulty. He went on to say that the weight of the induction motor is less than that of the continuous-current motor, and that it is cheaper and more robust. The system he had adopted had given no trouble whatever.

Mr. W. H. Stevens said that he advocated continuous-current series motors of the inter-polar type driving each back wheel. He explained that motors of this type can be short-circuited without damage. He also described a fool-proof controller used with his system, and also the governor, which is actuated by means of an electro-

magnet in series with the generator. The governor can be adjusted from the driver's seat. It was also mentioned that one of the special features of this governor is its suitability for economising in petrol. Some amusement was caused by Mr. Stevens' description of a safety device in the form of a switch which closes the circuit when the driver takes his seat, thus reducing the chances of the car starting without a driver to an absolute minimum. He mentioned that a London firm were putting to work an omnibus worked on this principle, and that a 14 horse-power vehicle would run for 18 to 20 miles on one gallon of petrol.

Mr. R. B. Mathews referred to some American cars with which he had experience. These were used for freight service in Cleveland, Ohio, on some of the branch lines which were not profitable enough to electrify. Four-cylinder petrol engines were employed, and the motors were without interpoles, and gave a good deal of trouble. In later cars Wolseley engines were employed, and the dynamos were provided with interpoles. These gave practically no trouble.

Mr. B. Hopps, representing the British Thomson-Houston Company, said that his company strongly favoured the continuous-current system. He then described the system at some length, and pointed out its principal features. He mentioned that the principal requirement for satisfactory performance is a constant watt output generator. By employing such a generator the load on the engine is maintained constant. He went on to explain that no form of direct connection between the engine and road wheels is employed, as the direct drive cannot be used for any length of time. Control is effected on the field of the generator. To stop the car the engine is first throttled and resistance then inserted in the field circuit.

Mr. W. Mordey referred to the pioneer workers and to a paper bearing on the subject read by himself in 1902. He called attention to the excellent starting torque of single-phase motors, and described some tests which showed that with one-third full load current these motors could give several times full load torque.

Colonel Crompton said that to electrical engineers it was difficult to see how any mechanical means could compare with the petrol-electric system. Accumulators could not be considered, as they were not of such value as the other means. If the number of parts were counted and their weights ascertained it would be found that the second system described in the paper stands at the best advantage.

Mr. Mavor spoke in favour of the alternating current system, and pointed out that the principal difficulty was speed regulation; he then explained a device for overcoming this difficulty by changing the periodicity of the generator. The device, however, was not yet in use.

Mr. Campbell Swinton, in replying, said that several of the speakers had quoted figures relating to fuel consumption per mile. He did not see that these figures were of any real value, for the consumption per mile was largely dependent on the road. If, for example, a car was running on a clear road the fuel consumption would obviously be different to what it was when running in a crowded thoroughfare with frequent stoppages. He also referred to the relative weights of purely mechanical and petrol-electric cars.

The second paper in this section was entitled

"THE APPLICATION OF ELECTRICITY TO THE WORKING OF RAILWAY POINTS AND SIGNALS,"

and was read by Luis de Moraes Gomes Ferreira. The author states that electrical transmission is generally acknowledged to be an ideal method of control in all signalling operations, and that there seems little reason for employing a second source of power, such as compressed air, when the controlling force in itself offers every advantage for doing the whole of the work. The railways have already had a great deal of experience with the various mechanisms for interlocking, and detecting and locking facing points, and have practically standardised the fittings on each line. In an electric system such standard fittings may be utilised. Signals may be operated either by long-pull magnets, solenoids, or motors. A force of 50 lb. to 80 lb. is required to be applied to the rod for working a standard signal, the amount of movement being about 4in. Electrical working, it was claimed, offered the simplest means for ensuring that the points or signals are in correspondence with their levers by means of return indication currents permitting the completion of movement of the levers and so releasing the mechanical locking. Dangerous movements through breakage or failure of any part of the apparatus or mechanical gear in an electric system might, he said, be safeguarded by arranging matters so that all safe operations are dependent on the presence of current, any failure of the same putting the signals to danger. It is obvious that, as all the cables can be placed underground, and in very restricted areas, an electrical system leaves the permanent way quite clear, and eliminates accidents due to rods or wires. The continuity of supply of energy is best maintained by the provision of storage batteries. After discussing the question of prime cost, the author said that, as the outcome of some years' experience and careful consideration of the problems involved, he had recently designed an electric system, embodying the necessary conditions, which would cost very little, if any, more to install than the usual mechanical signalling plant. The maintenance of an electric system should, he added, not cost more than that of the manual system, as the money spent in cleaning, oiling, painting, and renewing rods and wires was saved, and would be found to cover the cost of the electricity used, if an economical system were adopted.

Mr. E. D. M. Malon expressed his approval of the electro-pneumatic system, and stated that only 75 milliampères at 12 volts were required, the air pressure being 45 lb. to 60 lb. per square inch. He condemned solenoids, and said that with the system he advocated no clutch is required. He went on to speak of the small wear and tear of electro-pneumatic motors, and the difficulties attending the electrical system in frosty weather.

Mr. A. T. Blackhall, representing the Great Western Railway, said that they had adopted a permanent control electrical system at the Didcot Station, and the results were entirely satisfactory in every respect. The maintenance costs were extremely low, and the company is loud in praise of the system. He also referred to the wiring, which, he said, was rather complicated. He mentioned that check locking would probably be used in future.

Mr. Alex. Siemens spoke principally on the difference between the German systems and that described in the paper. He said that in Germany the positions of the points and signals were displaced by flags in the signal-box, and in the event of anyone tampering with the points or signals after they have been shifted, the signalman would know of the fact. He also said that there was nothing to equal electricity for satisfactory operation during frosty weather.

Mr. P. H. Peter spoke in favour of the electro-pneumatic system, and said that 40 million movements on his railway are operated every year with this system, and that they can depend on every motor for two years.

Mr. G. P. Annett also spoke in favour of the pneumatic system.

Mr. J. W. Jacomb Hood, among other remarks, expressed his disapproval of earthing all leads, except those actually carrying current. He also referred to the high cost of electrically operated signals, and said that the progress is very slow.

Mr. H. E. Morgan said that his company takes current from a three-wire system with 420 volts between the outers, and had experienced no trouble with earth currents. He said that with compressed air it was necessary to remove the moisture from the air during frosty weather, otherwise owing to condensation the pipes are liable to be choked with frozen water.

Mr. H. B. Holt said that he was in opposition to the statement that the solenoid is unreliable. He gave some interesting particulars concerning the solenoid system, and spoke of the small amount of wear and tear.

Mr. Thomas Parker said, as an old electrician, he was naturally much interested in the paper, but he considered that we are very slow in putting electricity to this important purpose, and hoped before long to see considerable developments in this direction.

Mr. Ferreira, in replying, said that in his system series motors were used, and that these were capable of considerable overloads caused by frosty weather, and it was quite unnecessary to increase the voltage at the terminals in order to cope with overloads. He assured Mr. Jacomb Hood that the system of earthing all leads except those actually carrying current had proved quite successful. He referred also to the simplicity of the clutch used in his system.

The last paper taken in this section on Wednesday was

"UPKEEP CHARGES ON LARGE ELECTRIC GENERATING SETS,"

by Henry Robert John Burstall, M. Inst. C.E., and John Somerville Highfield, M. Inst. C.E., who said: In dealing with the amount to be charged for repairs and maintenance, the fact that such charges do not depend entirely on the energy generated by the plant is at once brought into prominence. In any station in which extensions are not continuously going on, a special staff has to be kept for repairs. The expense of this is practically a constant quantity, and as the staff has to be of sufficient size to deal with an ordinary breakdown with expedition, it is generally larger than is absolutely necessary. A large portion of the upkeep charges is constant, independent of the units generated or hours run, and dependent approximately on the maximum output of the machines. The only part of the expense which will vary in any way with the hours of running will be the stores and materials expended. It would be of great interest if information could be obtained as to the number of men required for different stations of varying sizes. Considering the details of the upkeep charges, the authors separate the electric generators from the prime movers, and point out where the charges may be expected to arise. For direct-current machines, principally renewal of brushes and commutator repairs, which will vary greatly, were the only true upkeep expenses. For alternating current machines the cost of upkeep is negligible. The authors' experience of large alternating current generators was that, in a properly constructed machine well looked after, the bearings might be taken to last as long as the machine, and that, in machines exceeding 500 kilowatts output, and working with a maximum pressure to earth not exceeding 4000 volts, the risk of breakdown was very small; but with machines working at higher pressures than this, the risk, though still small, increases at a faster rate than the pressure. With reciprocating steam engines the upkeep charges appear to be independent of the type and speed, and the risk of breakdown is now very small. With steam turbines the upkeep charges should be smaller still, but there is little information available. The cost of upkeep of water turbines is almost entirely in the replacement of bucket wheels, and depends largely on the quality of the water used. The figures available for gas engines show that the parts which wear are the same as in a reciprocating steam engine, but that the upkeep costs are somewhat higher in some types of engines, owing to the complexity of the valve gear. A table was shown giving figures for some typical machinery. A comparatively large proportion of the upkeep charges are really for examination and overhaul, which should be done periodically, and bears no proportion at all to the hours of running. It should be remembered, the authors point out, that it might cost several times as much to take down and re-erect a machine as it did to effect the repairs necessary owing to wear. In their opinion, repairs and maintenance should be worked out on the normal power of the station, and not on the units generated, and should be compared on this basis. Any allowance for risk of breakdown, which was of the nature of insurance, would also naturally fall into the same category. They then gave an outline of how, according to their ideas, the cost of maintenance should be divided and sub-divided.

Mr. Lackie gave some interesting statistics relating to the cost of repairs in his stations at Glasgow. He also referred to the relative increase in staff with a growing load.

Mr. L. Atkinson spoke principally on the question of repairs. It had been his policy to rely on a good insurance company for emergency repairs, and by this method he has been able to keep the repair bill low. In his station of some 4000 kilowatts capacity there are never more than four men on duty at once.

Mr. J. J. Bell said that at one time his repair bill was high, owing to having a large repair staff. He has found, however, that by keeping two good fitters, one for the engines and another for the boilers, he has been able to reduce the expenditure very considerably. The great thing is to have efficient men. When a certain portion of the plant breaks down they always endeavour to find out exactly where the weakness lies and to improve on this particular portion of the plant, so that the trouble shall not occur again. By this means he hoped to reduce the repair bill as time goes on.

Mr. A. Goodwin referred to the satisfactory results obtained with turbines. A turbine of 1700 kilowatts capacity, running continuously during alternative weeks for two and a-half years, on being dismantled, was found in perfect order. As regards gas engines he was afraid that so far as repairs are concerned they would be much more expensive.

Colonel Crompton said that he agreed with Mr. Bell with regard to selecting the right men for repair work. At Chelmsford the costs were exceptionally low for a station of the size, and he attributed this largely to the class of men employed. He also referred to the low repair bill at a station in Calcutta, for which he is engineer. He explained that in this part the local conditions were exceptionally severe, and, owing to the heavy storms frequently experienced, trouble had been caused by the insulation of the machines breaking down. He said that it was expedient to endeavour to strengthen the weak parts of a plant when under repair, and pointed out that it was unfortunate that the account of improvements went to the cost of upkeep.

Mr. H. R. J. Burstall, in replying, expressed his regret at the unavoidable absence of his colleague, Mr. Highfield. He said that Mr. Lackie's figures agreed very closely with several London stations. He also referred to the high standing charges of London stations. One thing that had caused him considerable surprise was that the statement made concerning the impossibility of constructing a machine with closed slots, which will work at a pressure of 10,000 volts to earth, had not been disputed. It was a fact which they had learnt from bitter experience.

This section held no meeting on Thursday.

## THE ENGINEERING STANDARDS COMMITTEE.

### RAILWAY ROLLING STOCK.

THE British Standard Specifications for Material used in the Construction of Railway Rolling Stock—Report No. 24—have been revised, and will shortly be issued. The principal directions in which the various specifications contained in this volume have been revised are indicated below:—

The use of test piece C, having a gauge length of 2in. and an area of ¼ square inch, has been permitted in Specifications 1, 1a, 2, 2a, 3, and 3a for locomotive carriage and wagon axles.

In the specification for steel castings—Specification No. 10—the number of tensile and bend tests required for wagon wheel centres has been reduced, as it was considered that the quantity asked for under the existing specification was somewhat in excess of that usually obtaining in general practice. For locomotive wheel centres cast with heavy balance weights it has been made permissible to reduce the height of the fall in the drop test.

In connection with the specifications for copper and brass tubes for locomotive boilers—Specifications Nos. 13 and 14—an alternative drifting test has been added to the clause dealing with the bulging test.

The principal alterations in the specifications dealing with steel plates for locomotive boilers, locomotive frames and carriage and wagon frames, are in connection with the new Standard 4 diameter test piece for bars of over 1in. diameter. This shorter test piece has been introduced to reduce the amount of material required for testing and the amount of turning down when such is necessary.

In the case of rivets a temper bend test of the rivet steel has been added.

## NAVAL ENGINEER APPOINTMENTS.

THE following appointments have been made at the Admiralty:—

Engineer-Commanders.—A. E. Straw, to the Aquarius, on commissioning; A. V. Blake, to the New Zealand, and H. J. Coad, to the Mars, on recommissioning; R. W. Martell, to the Victory, additional, for the Fox; S. Rawling, to the Renown; A. E. Travis, to the Sentinel, on recommissioning; H. F. Daves, to the Pathfinder, on recommissioning; F. Marshall, reappointed to the Barham, on promotion.

Engineer-Lieutenants.—H. E. Brook, to the Topaze; W. Stokes and C. C. A. Stuart, to the New Zealand, and H. E. Wolfe, to the Mars, on recommissioning; A. E Ewart, to the Glory, and J. Maxwell, to the Pembroke, additional, as second assistant to the manager engineering department, Chatham Dockyard; J. B. Wilshin, to the Excellent, additional, for instruction in hydraulic gun mountings and for charge of engineer stores, and E. E. Lewis, to the Hecla, for the Flirt; H. H. Gordon, to the Blenheim; C. H. Johnson, to the Sentinel, on recommissioning; W. Begg, to the Pathfinder, on recommissioning; J. A. Anderson, to the Blenheim, for the Ettrick.

Engineer-Sub-Lieutenants.—W. H. Pudner, to the New Zealand, and G. Hick, to the Mars, on recommissioning.

THE ENGINEERING GOLFING SOCIETY.—At a general meeting of the Society held at the Westminster Palace Hotel on Monday last, a set of rules was framed, and the following officers elected for the current year:—Captain, Mr. J. W. Jacomb-Hood; treasurer, Mr. R. W. Hammond; committee, Messrs. J. F. Albright, B. Hall Blyth, E. B. Ellington, E. L. Mansergh, F. J. Walker, Prof. Cormach, Dr. J. H. T. Tudsbery, and Dr. Hele Shaw; Hon. Secretary, Mr. Seymour Price Williams, 5, Victoria-street, Westminster, S.W.

## RAILWAY MATTERS.

IT is proposed to increase the carrying capacity of the Moscow and Kursk Railway by expending £270,000 on the line.

A NEW station at Salisbury-road, between Brondesbury and Kensal Rise, is to be erected at once on the North London Railway.

THE traffic receipts of the Geneva tramways for the month of May, 1907, amounted to £5499, an increase of £527 compared with 1906.

ON Saturday, June 22nd, the opening day of the Charing Cross and Hampstead Railway, 150,000 passengers were carried on the railway free of charge.

THE Midland Railway Company is about to erect a new goods shed and stables at Luton. The shed will be of unusual dimensions for a town of this extent.

WE hear that the construction of the Saldanha Bay-Porterville Road Railway, Cape Colony, is being strongly opposed by the Government Railway Committee.

THE Italian State Railway has bought 200,000 tons of American coal, to be delivered at Genoa at 23s. 6d. per ton. The Welsh coalowners, it is said, asked 25s. 6d.

THE Genoa Electric Tram Company proposes to construct lines on private roadways, only using the public roads at crossings. The estimated cost is £2,000,000.

AMONGST the most urgent needs of Greece is the linking up of its railway system with the rest of Europe. Some progress towards this end has been accomplished during 1906.

IN Hungary the narrow-gauge railroads are of fifteen different gauges, from 18in. to 39in. The Government have now decreed that henceforth such railroads may be built of only two gauges, 70 cm. and 76 cm. = 27½in. and 30in.

THE first task set for the new central office of the Prussian State railroads is a thorough examination of the rules and regulations for the different branches of the service, with a view to such a revision as will secure greater clearness and uniformity.

AN electric tramway service will probably be started in Shanghai this month. A native paper has been urging the Chinese guilds to organise a boycott of the trams, and it declares that the dangers from the speed of the trams and live wires must cause innumerable fatal accidents.

THE new Great Western Railway engine shed at Oxley sidings, near Wolverhampton, which has been erected to accommodate nearly 100 locomotives, was recently inspected by numerous railway officials. This building will now be gradually brought into use to relieve the old sheds adjoining the Stafford-road Works.

AN experimental railroad for testing signalling devices, materials used in track construction, and different types of motor cars for railroad use, has been built by the railway department of the German Government. The road is double-tracked, and is oval-shaped, having a length of 5760ft. The straight stretch is about 800ft. long.

WE hear that a meeting was recently held in Pittsburg to discuss the feasibility of establishing there a museum of railway relics of historic interest. It was pointed out that early engines possessed for young engineers considerable educational interest, and that there should be no difficulty in establishing a really valuable collection.

ON Tuesday, June 18th, a 15ft. rail from the Leicester and Swannington Railway, together with three stone blocks—dated 17th July, 1832—were placed in position in the yard on the Princess-street side of the Leicester Museum. A few feet of the Roman stone track as used on the Fosse-road is also laid down as originally employed.

IT is understood that the Benguella Railway, Portuguese South Africa, will be pushed on as rapidly as possible to Katanga, where extremely valuable deposits of copper and other ores await development. The other South African systems, it is alleged, will in no sense be adversely affected by the development and inter-communication in Central Africa.

REPORTING on the subject of the speed of the London County Council electric cars at the meeting of the Shoreditch Borough Council, the Highways Committee expressed the opinion that the limit of 16 miles an hour for Kingsland-road and Shoreditch High-street was excessive, and they recommended that the attention of the Board of Trade should be drawn to it.

EARLY in 1907 the French Government published a decree promulgating a convention signed at Paris on August 18th, 1904, and an additional protocol dated March 8th, 1905, between France and Spain for connecting the two countries by a railway system passing through the Central Pyrenees. This system will comprise three lines:—(1) From Oloron to Jaca; (2) from St. Girons to Lerida; (3) from Ax-les-Thermes to Ripoli.

THE London County Council have given notice to the Hackney Borough Council of their intention to proceed with the electrification of the tramways in Mare-street, Clapton-road, Upper Clapton-road, Lauriston-road, Graham-road, Dalston-lane, Ball's Pond-road, &c. The Borough Council are considering whether the maximum speed of the County Council tramcars on the Stoke Newington route, viz., 16 miles an hour, cannot be reduced.

ACCORDING to the *Iron Age*, the gyroscopic action of revolving armatures in street railroad cars has a tendency to sustain the car in the line of motion and consequently to resist strongly any attempt to swerve it from that line. It is believed that the present formula used for the elevation of the outer rail in steam practice may not be applicable to high-speed electric railroad practice, particularly when the armature is not mounted on the axles of the car.

THE Hudson and Manhattan Railroad announces that it is expected by 1st October to operate the line from Hoboken to Fourteenth-street and Sixth-avenue, New York. The first of the fireproof cars has been delivered. The two lower tunnels to extend from the Pennsylvania Railroad station in Jersey City to the terminal building at Church and Cortlandt streets, which it is hoped to have ready for occupancy by 1st May, 1908, are about 75 per cent. completed.

THE Tramways Committee of the Bolton Corporation recently conducted a series of trials with a petrol-electric motor omnibus, with a view to finding out whether it would meet the heavy demands of a rough, steep stretch at Darcy Lever and Brownlow Fold. The vehicle is constructed to carry 34 passengers—18 outside and 16 inside. It is of 30 horse-power, weighs 4 tons, and its chassis cost £900. During the trials the maximum load carried at any stage was 22 persons.

A MASS meeting of railwaymen from various parts of Norfolk held on Sunday last in Norwich passed a resolution approving of the all-grades movement and promising to support it. Mr. Bell, M.P., gave a long address, and said railwaymen felt they ought to have the power to send their accredited representative before the directors to present their grievances, as was the case with all other organised trades. It was time, too, there was a review of the conditions of labour, a reduction of hours, and increase of wages. The rank and file were heartily in favour of the movement, and would stand by it whatever the result.

## NOTES AND MEMORANDA.

THERE are said to be at present 250,000 miles of cable in all at the bottom of the sea, representing £50,000,000. This works out at about £200 per mile to make and lay.

THE United Steel Company, Canton, O., recently made a heat of about 30 tons of vanadium steel, which is claimed to be the largest heat of this class of steel thus far made.

IN the five months ending May 31st last, 6,939,828 tons of coal and 125,876 tons of coke were shipped from the Tyne, as compared with 6,807,281 tons of coal and 124,050 tons of coke in the corresponding period of last year.

CEMENT for fastening iron to marble may be made of 30 parts of plaster of paris, 10 parts of iron filings and 1 part of sal ammoniac, mixed with vinegar to a fluid state. As the mixture hardens quickly, it must be prepared for immediate use.

ACCORDING to the *Engineering and Mining Journal* greater working stresses can be taken by the use of steel chains of the same weight than is possible with malleable chains. The natural defects and flaws to which malleable castings are subject are avoided in the use of steel.

THE exports of coal at the port of New York in 1906 were small, consisting of 77,000 tons of anthracite and 36,000 tons of bituminous, destined principally to Cuba, Bermuda, and the West Indies. Over 5,125,000 tons, valued at £3,240,000, were supplied during the year at different ports in the United States as fuel for steam vessels.

A TOTAL of 1,250,541 tons of foreign iron ore was imported into Belgium during the four months ending with April last, as compared with only 1,184,940 tons in the corresponding period of last year. There has also been an increase in the exports of Belgian iron ore—from 134,386 tons in the first four months of 1906 to 150,523 tons in the four months ending with April last.

ANODE rays can now be obtained without heating the anode by using very low pressures. They cause the glass to fluoresce green; if they fall on a salt the lines of the metal are given. Their path is apparently independent of the position of the cathode, and they carry with them the salt of which the anode is formed. They appear to possess most of the properties of canal rays.

BY covering the boiler setting with a layer of asbestos cement, pasting over this a canvas, and painting the whole with a heavy coat, an American engineer, has, it is said, been able to effect a saving of about 12·5 per cent. of his coal bill. It is stated that thoroughly coating the brickwork with red paint so as to fill the pores will cause a considerable saving of fuel in almost any boiler.

IN Ohio during 1906 there was one life lost for every 214,279 tons of coal mined, whereas in 1905 it was 226,628 tons, showing, states the *Engineering and Mining Journal*, the increased danger to which the miner of the present day is subjected, and the necessity for new mining legislation in order properly to protect those who work underground. There was one life lost for every 366 persons employed.

THE longest single-span bridge in concrete in the world is now in course of erection over the Wissahicken ravine, near Philadelphia. The central span of this bridge will measure 233ft., and there are four smaller spans each of 55ft. The total length of the complete structure will be 520ft., and the width 66ft. The height of the roadway above the bed of the creek will be 125ft. The cost is set down at £51,200.

IN the electrolysis of fused sodium nitrate the best yields of nitrate and oxide are obtained with graphite electrodes. Rise in temperature, or increase in the current density, gives a better yield, and direct current is better than alternating. An increase in voltage diminishes the yield. Superimposed on the action of the current is the reducing action of the powdered graphite formed from the electrodes during electrolysis.

EXPERIMENTS by a chemist of Bessemer, Colo., says the *Engineer*, Chicago, seem to show that from one species of cactus a vegetable juice is extracted which when used in feed-water of boilers will eliminate the scale-forming constituents. The exact formula for making the compound is a secret, but it is to be exploited and manufactured for market at a cost estimated to be considerably less than that of the usual chemicals.

IN a novel method of toughening metals lately introduced the metal to be treated is placed in a closed retort with a small quantity of mercury; the retort is subjected to pressure, and as it is heated to a point below melting temperature, a current of electricity is passed through the metal. Besides increased toughness, greater resistance to sea-water corrosion is imparted. The hardening is especially adapted for iron and steel, but is claimed to be useful for other metals.

INVESTIGATIONS made on the distribution of the magnetic field and the flux of induction in a bundle of conducting wires forming the core of a solenoid traversed by a sinusoidal current or the discharge of a condenser, show that the period of the discharge is proportional to $\sqrt[3]{\mu\delta}$, where $\mu$ is the permeability and $\delta$ the specific resistance of the material of the core. Thus the period is reduced from unity to 0·0542 by substituting a copper core for an iron core.

THE experiments recently made in Vienna by Professor Reithoffer, in conjunction with Herr Morawetz, a clock-maker, to introduce a system of regulating public clocks by means of wireless telegraphic impulses have, it would seem, proved successful. A clock on this principle was tested on May 3rd by Mr. Klose, and was found to be wholly uninfluenced by stray currents, and kept perfect time in accordance with the regulating clock 3·72 miles distant, which controlled its movements by wireless telegraphy.

TO find how many electric lamps are required to light a room the *Brush Bulletin* gives the following formula:—Multiply the average length in feet by the average width in feet. Suppose, for instance, that the result is 250 square feet. If it be an important room, say, a drawing-room, allow a quarter of a candle-power to each square foot, according to the decorations. About four lamps of 16 candle-power each or eight lamps of 8 candle-power each would suffice for this room unless it had a very dark shade of paper and furniture.

THE suggestion has been made that the application of the Gayley dry air process would do much toward meeting the condemnation of Bessemer steel prevalent among some railway engineers. The mixer used has in one direction thoroughly minimised one source of fluctuations in the character of the metal. The range in silicon contents in the iron charged in successive heats has become very narrow, but the conditions are rarely identical day after day in temperatures, and the one variable factor is the amount of moisture introduced with the blast.

ELECTRICAL air filtration is suggested by an experimenter, who has discovered that a body positively electrified to 100 volts or over will, if placed in a sooty atmosphere, become covered with soot in a day, while a negatively charged body remains comparatively clean. In an application of this discovery to the fan intake of a ventilating system, a sheet of wire gauze was inserted in the intake flue, and electrified by connection to the positive of a 250-volt supply main. The gauze is reported to have extracted large quantities of soot from the air.

## MISCELLANEA.

THE Farsley District Council has applied for an extension of time in which to transfer or lease its Electric Lighting Provisional Order.

PUMPING operations in connection with the re-opening of Great Wheal Busy Mine, Blackwater, have been commenced, the engines having been tested on Saturday.

IT is reported that efforts are being made to establish a steel works union in St. Petersburg on the lines of the Stahlwerks Verband, but adapted to suit Russian trade conditions.

THE Italian Minister of Marine has brought in a Bill for the purpose of establishing seven stations of wireless telegraphy in Eritrea; two of the stations are to be of extraordinary power.

AT a meeting in Newcastle on Saturday last in connection with the proposed strike of engineers in the Tyne and Tees district 931 voted against and 548 for stopping work on June 29th.

WHILST sinking operations were in progress at a new pit at Fredville, near Canterbury, on Saturday, June 15th, an inrush of water took place, flooding the workings to a depth of 150ft.

THE authorities of Shanghai, one of the busiest towns in China, have passed a by-law allowing motorists to maintain a speed of not more than thirty miles an hour while passing through the city.

AT a recent meeting of the Manchester trade union colliers resolutions were passed in favour of urging upon their representatives in Parliament the necessity for supporting the Mines Eight Hours' Bill.

THE chairman of the Belfast Harbour Board, at the Commissioners' statutory meeting, stated that plans had been submitted by Messrs. Harland and Wolff for an extension of their Belfast shipyard to cost £50,000.

A FRENCH Ministerial decree authorises the Société des Forces Motrices du Rhône to utilise the electric energy of the Jouage diversion for lighting three communes in the department of the Rhône and one in Isère.

IN repairing the submarine cable between Iquique and Valparaiso, says the *Electrical Times*, the cable ship Faraday hauled up from a depth of 400 fathoms a whale entangled in the cable, the evident cause of its breakdown.

WE hear that the Sheffield Chamber of Commerce has been discussing the National Telephone Company's proposal to increase its charges in Sheffield. Apparently there was no definite result, as the meeting was adjourned.

IT is reported that the construction of the new bridge over the Blue Nile at Khartoum is to be commenced directly. It will be three-quarters of a mile long, have a railway, roadway, and footway, and take two years to build.

EFFORTS to float the steamer Ailsa, which, with a cargo of timber, went aground in the Channel at the entrance to Silloth Harbour on Friday last, have proved successful. The vessel has been got safely off, and is none the worse for her adventure.

THE Wishaw Town Council has decided to raise the price of both gas and electricity. At present the charges are: gas, 2s. 5d. per 1000 cubic feet, and electricity 3d. per unit. The new rates will be: gas, 3s. 1d. per 1000 cubic feet, and electricity 3½d. per unit.

THE Worcester Town Council have decided to make application to the Local Government Board for sanction to a loan of £10,000 for a further extension of the Hylton-road generating station and machinery there, and laying mains and services, and providing meters, &c.

ON Wednesday, June 19th, a fire broke out in the winding engine-house of the Gordon pit at Little Raith Colliery, Lochgelly, Fifeshire. The roof of the building collapsed in less than half an hour. All the workmen below ground, however, numbering between 200 and 300, made good their escape by means of another shaft.

THE Russian Council of Ministers has been asked to consider a project for establishing telephonic communication between Moscow and Nishni-Novgorod, Moscow and Ivanoff-Voznessensk, Kharkoff and Yekaterinoslav, and Kharkoff and Bakhmut. The projected telephone lines would be laid down by private enterprise.

ON Tuesday last about 1500 labourers at Salford Docks ceased work, owing to a refusal on the part of officials to accede to an informal request for an increase in their wages. The men engaged in unloading timber commenced the trouble in the morning by making a verbal demand for payment at the rate of 8d. per hour, or 6s. per day, instead of 7d. per hour, the present rate of pay.

IN the course of his evidence before the Paris Municipal Council, as to means for relieving the intense street traffic, the Prefect of Police acknowledged that the English system of keeping to the left instead of to the right had many advantages, but would not take upon himself the responsibility of the many accidents that making such a revolutionary change in Paris would almost certainly involve.

WHILE working a coal train on the single line of the Hull and Barnsley Railway, which connects up the coaling ports with the Denaby and Cadeby Collieries, a driver on Tuesday noticed about fifty yards ahead a large quantity of earth coming on to the line. He had only time to shout to his fireman to jump and to apply the brakes before they reached the obstruction. This the engine mounted and remained on it with one end in the air.

WE hear that arrangements have been made for working the deposit of asbestos in the Minusisk district, near the village of Battenei, Siberia. The deposit is reported to be rich, and all the local conditions favour its development. It lies in the midst of a populous district about 10 to 15 versts from the Yenissei River. This will, we believe, be the first asbestos enterprise established in Siberia, although Russia proper has been a producer of asbestos for a long time.

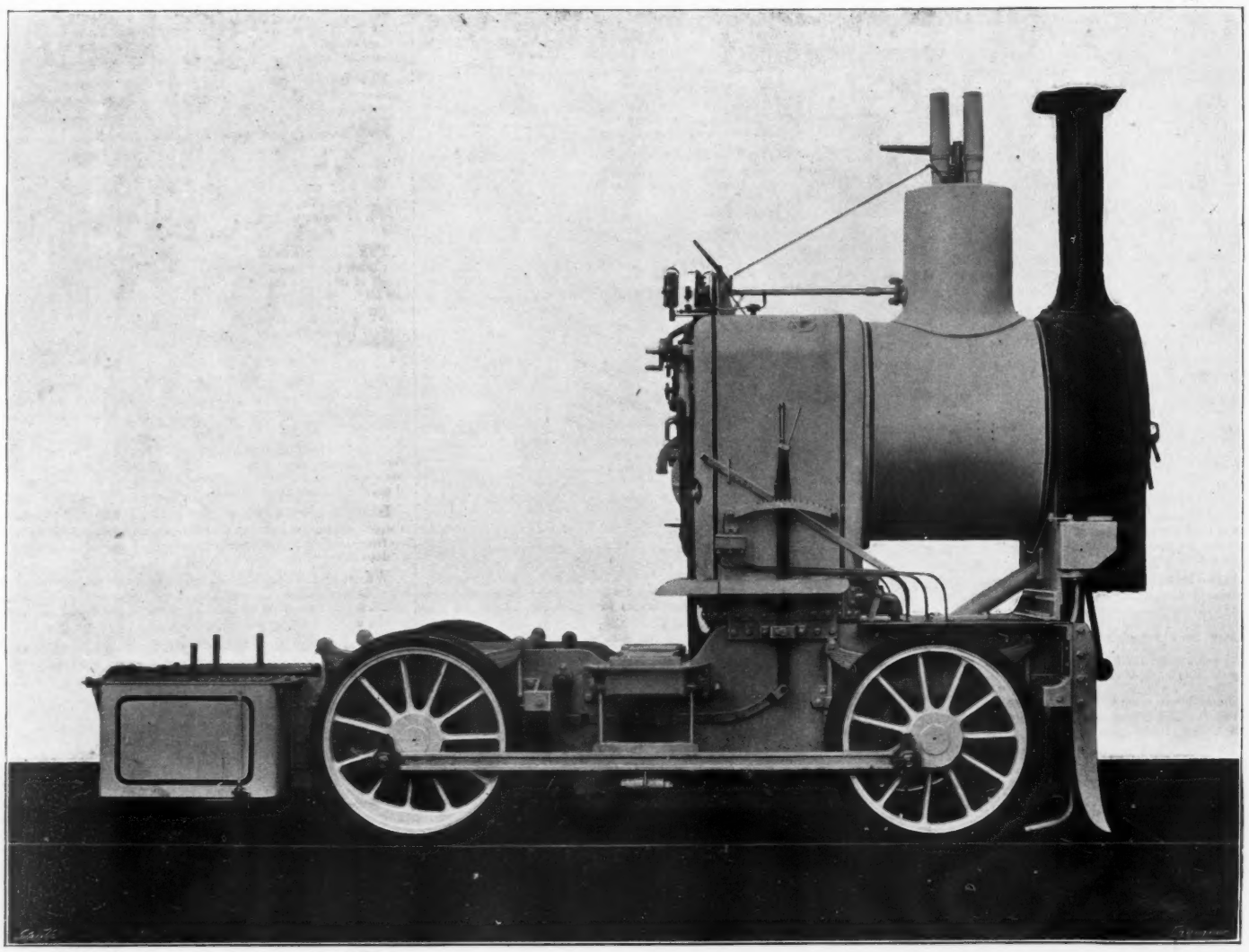
THE first practical trial of the new coaling appliances at the Bluff, Port Natal, took place recently. Although the power installation is not ready for use, and the test cannot therefore be regarded as finally showing the capacity of the machinery, it appeared to work efficiently, the average quantity shipped per hour being from 200 tons to 250 tons. It is expected that the previously announced charges will probably be reduced from 10d. to 7½d. per ton for export, and from 10d. to 7½d. per ton for bunkers.

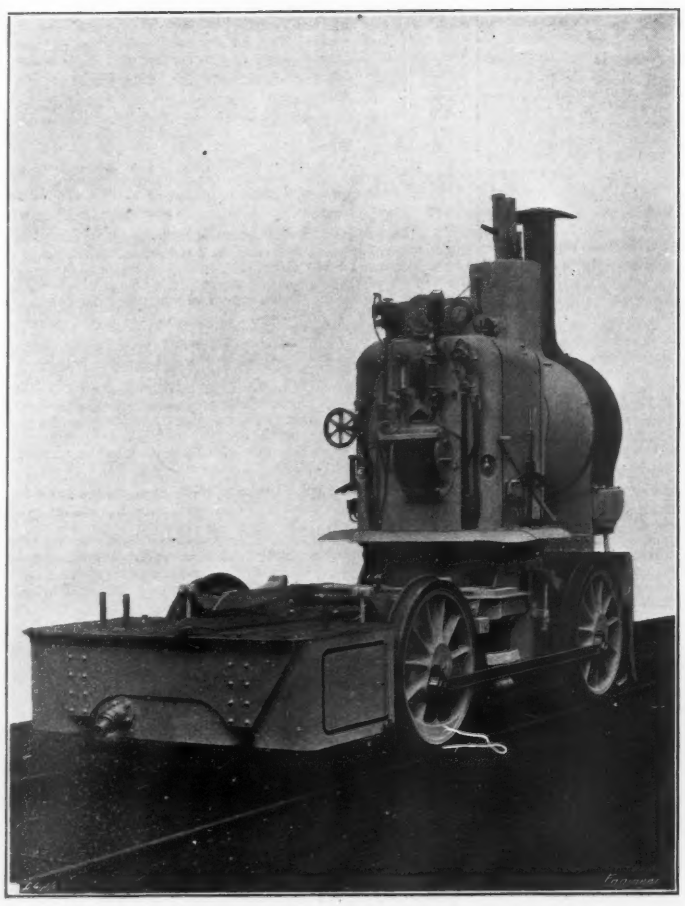
ACCORDING to a contemporary, Professor Angström, of Upsala has been continuing his experiments as to the amount of heat given out by radium. Professor Angström kept a piece of radium bromide, 86·5 milligrammes in weight, under observation for sixteen months. He found that the heat emitted amounted to 1·14 small calories per minute, or 68·5 per hour, per gramme of the substance, a small calorie being the amount of heat required to raise one gramme of water 1 deg. Cent. From this it may be calculated that 6 oz. of radium bromide would in one year give out sufficient heat to raise one ton of water from freezing to boiling point.

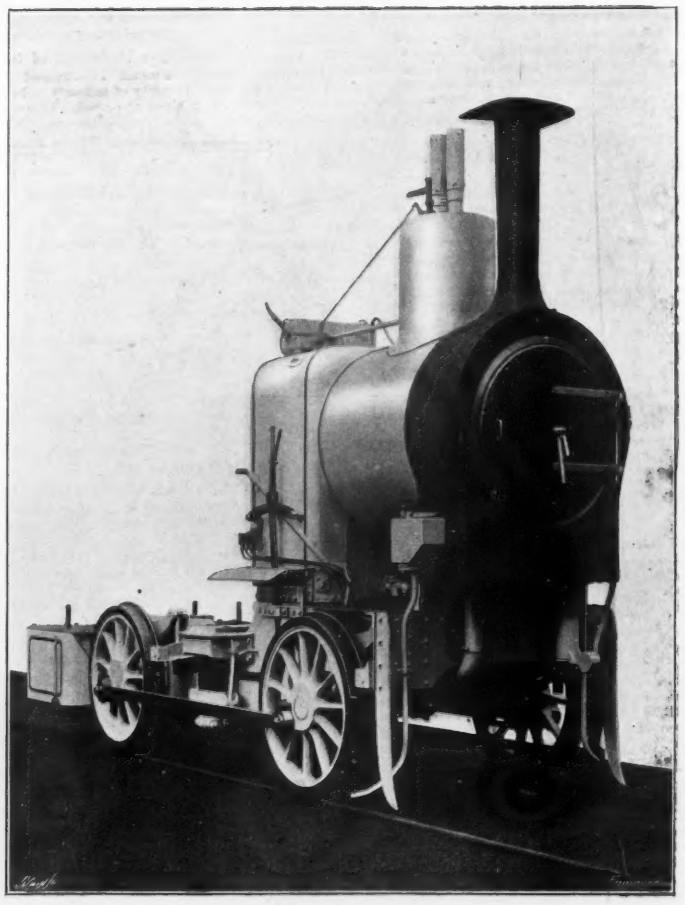
# ENGINE OF MOTOR COACH FOR EAST INDIAN RAILWAY

NASMYTH, WILSON AND CO., LIMITED, PATRICROFT, ENGINEERS

*(For description see page 660)*







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**Advertisements cannot be inserted unless delivered before Five o'clock on Thursday evening, and in consequence of the necessity for going to press early with a portion of the edition ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Tuesday morning in each week.**

*Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of* THE ENGINEER.

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## TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

### REPLIES.

D. R. AND CO. (Madras).—Your letter has been forwarded as requested.

A. M.—We have no doubt that the simple instrument you have designed for clearing water gauge cocks would act perfectly.

M. M. H.—We regret we are unable to give you the information for which you ask. Possibly the Commercial Department of the Board of Trade could help you.

G. T. A.—We could not give you the information for which you ask without the expenditure of a good deal of time. Why not write to a few of the principal contractors and ask if they have vacancies on any of their works?

A. S. (Donington).—The Admiralty no longer permits sections of British ships to be published, and we have given none for many years. The only fairly recent sections are those of the American battleship Alabama, given in our issue of April 9th, 1897.

J. B.—(1) You can get full particulars by applying to the Board of Trade, Marine Department Whitehall. (2) The best insurance companies are now very particular about the men they appoint. As a rule they hold first or extra first certificates. A thorough practical training is required.

J. P. (Dublin).—If the Dominion Agents have given an unsatisfactory reply, as your letter seems to suggest, we expect the openings are not good. Probably your best course would be to get the names of a few contractors or resident engineers and write to them. Or you might try an advertisement in a Canadian paper.

H. D. R.—(1) No other metal in common use can be hardened and tempered like steel. Some of the bronzes are naturally very hard, and cutting tools can be made from them. (2) Nickel is very hard metal and corrodes very slowly. It is, however, very brittle unless prepared with great care. Several of the alloys of copper, zinc, and tin with antimony are hard and but slightly corrosible.

W. K. H. S.—Besides those you mention the following are the principal firms:—John Mowlem and Co., Grosvenor Wharf, Westminster; Sir W. Arrol and Co., 32, Victoria-street; John Aird and Son 37, Great George-street; Sir J. Jackson, 53, Victoria-street; Perry Bros., 2, Whitecross-street, E.C.; Pethick Bros., 2, Army and Navy-mansions Victoria-street; Foster and Dickson, Rugby; and Dick, Kerr and Co., Limited, Cannon-street.

SECRETARY.—Yes, the Lynn Works are in the United States. Several firms have now schemes for the education, encouragement, and management of apprentices. Besides Clayton and Shuttleworth we might mention, amongst others, the London and South-Western Railway Works, Nine Elms; Yarrow's Works, Isle of Dogs, Poplar; Scott's Engine Works of Richardson, Westgarth and Co.; and the Brush Company, Loughborough.

D. DE R.—We cannot go fully into a question of the kind here, but suggest that you put the question to yourself the other way round. What advantages has heated and compressed air over steam? You will find that when all the compressing and storing plant—which is more costly and weighs more than a battery of boilers—and when the losses in transmission, the mechanical troubles, and all other points are taken into account that, except for transmission on a small scale, air, in spite of its apparent advantages, is out of it.

G. B. (Carshalton).—All the largest makers are included in the following list:—Bolckow, Vaughan and Co., Limited, Middlesbrough; Cammell Laird and Co., Sheffield; Dorman, Long and Co., Middlesbrough; Dowlais Iron Company, Dowlais; Ebbw Vale Steel, Iron, and Coal Company, Ebbw Vale; Barrow Hæmatite Company, Barrow; Crawshay Bros., Cyfarthfa; Moss Bay Hæmatite Company, Workington; North-Eastern Steel Company, Middlesbrough; Tredegar Iron and Coal Company, Tredegar; Sheepbridge Coal and Iron Company, Chesterfield; Steel Company of Scotland, Glasgow.

### INQUIRIES

BORN'S TACHOMETERS.

SIR,—I should be obliged if any of your readers could give me the name and address of the makers of Horn's Tachometers and Tachographs.
June 26th. B.

### MEETINGS NEXT WEEK.

RAILWAY CLUB.—Thursday, July 4th, at 3.30 p.m., members will meet at Swannington Station, Leicestershire, and will visit the Pumping Engine, also the Charnwood Forest Canal and the Coleorton Railway.

# THE ENGINEER.

*JUNE* 28, 1907.

### Wheel and Rail.

WE fear that the facts brought out during the recent discussion on wheel and rail at the Institution of Civil Engineers do not redound to the credit of those concerned in the design of the rolling stock of railways worked by electricity. It is admitted on all hands that the rails wear out with disastrous rapidity; but it does not appear that the reason why has gone home to the intelligence of the responsible authorities. The facts lie in a nutshell. While the Metropolitan, for example, was worked by steam locomotives, rails had a life measured by years. The introduction of electric traction has resulted in shortening the life of the rails to months. No one supposes that electricity, *per se*, has any influence. The permanent way has not been altered; the rails are of the same texture, weight, chemical composition as before; the only element changed is the construction of the rolling stock. Common sense leads, of course, directly to the logical conclusion that the rolling stock is in fault, and that to it, and to nothing else, must we look for an explanation of the speedy destruction of the permanent way.

Now, so far as is known, the stock has been designed by men with no traction experience outside tramways. They are electricians first, and railway engineers a long way afterwards. Their contention is that the rail is in fault; but as pointed out by Mr. Burnett whose long experience as Locomotive Superintendent of the Metropolitan Railway enables him to speak with authority, the rolling stock is wrong. The bogies are too short, and when the brakes go on they can no longer radiate to a curve. The grinding away of check rails is almost unprecedented; the wheels are far too small; and it does not appear that adequate side play has been left between the axle-boxes and the horn plates. We venture to assert that had experienced railway engineers or carriage superintendents been consulted, the rolling stock would not have been just what it is. It may, perhaps, be argued that when electricity is used for traction, only small diameter wheels and short bogies are admissible. If we are to regard present designs as final, then so much the worse for electric traction. Our own view of the question is that it is not electricity, but the designers who are responsible. As one speaker said in the course of the discussion, a fatal mistake was made when tramways were selected as a precedent instead of railways.

Mr. Mallock's paper carries our memory back to an inquiry made more than forty years ago on the Great Eastern Railway to ascertain the area of contact between a driving wheel and a rail. Much difficulty is met with in doing this. The adhesion of locomotives was discussed at great length before the Society of Engineers in November, 1865. The general result was that the area of contact might be taken as about half a square inch with a new tire and a new rail, the load being about eight tons; but the condition of the rail and of the tire so modified results that the only thing certain was that the loading always exceeded the elastic limit of the materials, which therefore ought to crush. Two reasons were brought forward to explain the fact that crushing did not take place in the ordinary sense of the word. The first was practically identical with that advanced last week by Mr. Hopkins, namely, that a suddenly applied and removed stress could be borne, which could not be sustained for an appreciable time. The time element was introduced, and it was said that the metal had not time to give way. This explanation, however, could not deal with the case of an engine standing at rest on the rails. The explanation of the reason why crushing does not then go on will be best understood by supposing a case. Let us imagine that we have a hard rail, and that on it we place a small rectangle of steel, with, say, an area of half a square inch—the rectangle is one-fourth of an inch thick. If, now, we apply a load of, say, nine tons to this, deformation will take place, the steel rectangle flattening and spreading. But let us suppose that an excavation is made in the rail head, and the rectangle accurately fitted into this excavation; then deformation cannot occur, because the rectangle, being *encastré* and supported all round, cannot spread. In other words, that portion of a rail which carries the load, whether constant or momentary, is so bound together by the surrounding portions of the rail head that it cannot give way.

The rails in a tube are spared the effect of hammer blow, and in so far ought to be the better off than when carrrying a steam locomotive. That they are not is proved by their short lives. No one in the course of the discussion said anything about slip. It seems to be taken for granted that only steam locomotives slip. Now the slipping on tramways is very heavy, and in damp, greasy weather it is only by the profuse use of sand that moderate inclines can be surmounted. There is every reason to believe that a great deal of slipping goes on in tubes, and that no one knows anything about it. No doubt the wear and tear of rails in tubes is undergoing careful inquiry; but one of the first steps of that inquiry should consist in fitting counters to the bogies, so that the total number of revolutions made per mile by the driving wheels may be known. A 3ft. wheel makes about 560 revolutions per mile. If it is found that it makes 600, the difference is slip. The test is so easily and cheaply made, and the result would do so much to eliminate or establish the existence of one potent factor, that it is scarcely possible that the experiment will not be made. It appears to us that, in one sense, tube rolling stock has been designed on quite too insignificant a scale. It has been looked upon as a species of toy rather than plant which must do very hard, continuous work. What the cost of maintenance may be there is no means of judging yet, because most of the lines are quite new, and of those that are not no detailed reports have yet been made public. There is, unfortunately, no reason to believe that they will be moderate. It should, for example, be carefully kept in mind that the wear and tear, which are so excessive, cannot be confined to the rail. Files will not last for ever.

Flanges cannot punish check rails and go scot free. The rail will certainly retaliate.

The imperative need of the moment is more flexibility in the rolling stock. To put in harder rails is to treat symptoms, instead of attacking the agency to which the symptoms are due. It would appear that the bogies are too tight to gauge; they are far too short in the wheel base; in some cases they are made without any traversing gear; they are not sufficiently braced diagonally, and the parallelism of their axles is not fully maintained. There ought to be no difficulty in designing bogies on the Bissel truck system, which always gave great satisfaction as fitted to the steam locomotives. The brake gear needs complete remodelling. Much of the worst wear and tear takes place in stations which are on curves. No one during the discussion had a single word to say in favour of the brakes as now fitted. Indeed, not one argument in favour of the existing rolling stock was heard. It was assailed in several quarters, but the attacks were received in silence. No man had anything to say in defence of designs which are doing so much to render themselves intolerable, that nothing, we suspect, but lack of funds prevents the introduction of very substantial alterations.

### Coal Prices and Exports.

THE outlook for coal consumers throughout the country is far from promising at the present time, on account of the large increases in prices which have taken place in recent months, and which have no prospect of undergoing a reduction within a conceivable period. All classes of consumers, whether engineers, manufacturers, or railway and gas companies, together with the users of coal for domestic purposes, are affected more or less by the upward movement, which started about the time when the export duty on coal was abolished at the end of last October, and which is very prominently connected with the transactions in foreign markets. The coal trade was one of the last branches to participate in the general improvement in manufacturing and industrial enterprises during the past two years, but it has made a considerable advance in a comparatively short period, and is doubtless producing a golden harvest for the coal owners. During the five years and a-half of the operation of the export duty on coal the impost yielded to the National Exchequer, as recorded in a Treasury return, a total sum exceeding £11,000,000. Now, if this amount was paid by the coal owners or exporters, as has always been their contention, it will be obvious that the removal of the tax has released them from a very severe financial burden; but it is by no means certain that they were called upon actually to defray all, or any, of the shilling per ton duty on coal of the value of six shillings per ton and upwards. If, however, the coal owners' view of the position is accepted as the correct one, they are deriving a double advantage at the present time—first, by not having to pay the export duty; and, secondly, by reason of the large increase both in home and export prices. On the other hand, the wages of the coal miners in most of the producing districts have been raised in recent months, and industrial peace is assured in the federated area and in South Wales for the next two or three years, owing to the binding agreements between the coal owners and the miners. In May alone, according to the memorandum of the Board of Trade, no less than 270,000 coal miners received an advance in wages, or a total of nearly one-third of the aggregate number of miners employed throughout Great Britain.

The general improvement in the trade of the United Kingdom, and the increase in the wages of the miners, are not the only causes which are responsible for the augmentation in the prices of fuel to inland consumers, as the shipments to other countries have largely contributed towards bringing about the present situation of affairs. In fact, the period of industrial prosperity also prevailing in certain continental countries stimulated the exports of British coal during 1906, and it has continued to operate in this direction in the first six months of the current year. Even the defunct export duty, which the coalowners declared was hampering the trade, failed to arrest the progress of the shipments, seeing that the exports of coal increased in every financial year during the time the tax was in force. The abolition of the impost at the end of last October only left two months of 1906 free from its operation. Yet the total exports of coal in that year, exclusive of bunker fuel, amounted to 8,400,000 tons in excess of the exports in 1905, which in turn exhibited an increase of 1,100,000 tons over the preceding year. But exceptional circumstances existed in 1906 on account of the industrial prosperity in Germany, Belgium, and Italy, and the disaster at the French colliery at Courrières, and the subsequent general strike of coal miners in the Nord and the Pas de Calais. It was consequently possible for exporters to maintain the exports of coal to Germany at 7,600,000 tons in 1906, or, practically, the same quantity as in the preceding year, which was specially advantageous to British exporters owing to the strikes of coal miners both in Germany and Belgium. An enormous advance of 2,700,000 tons took place in the coal shipped to France in 1906, and augmentations were also recorded in the case of Italy, Holland, Belgium, Sweden, and other countries. The progress has continued this year, and in the first five months the exports show an increase of 2,100,000 tons over the corresponding period of 1906, of which about 80 per cent. represents additional quantities forwarded to Germany, France, Holland, and Belgium.

The continued expansion in the exports of coal is, without doubt, a gratifying event to producers, although, it is to be feared, that in the promotion of the foreign trade in this raw material the needs of home consumers are not receiving all the attention they deserve, especially in the matter of prices. It is, perhaps, easy to understand the development of the export trade to countries which either have no native supplies of coal or an insufficient quantity for their own requirements, as, for instance, France, Italy, Spain, Holland, and certain other countries; but it is difficult to comprehend why every endeavour should be made to increase the exports to any country which has ample supplies of fuel within its own frontiers, when by so doing the exporters cannot derive any permanent advantage. Year in and year out during the present century our coalowners have complained of German competition and loss of markets, and they have, in some cases, been supported by consular statements recording arrivals of German coal at foreign ports. While losses may have been incurred in particular cases, the export trade, as a whole, has not suffered, as is demonstrated by the annually increasing tonnage of shipments. But the coal exporters themselves, unconsciously as it may appear to them, are simply placing facilities in the way of their German rivals, as every ton of coal forwarded to Germany releases a ton of German coal for the export market. In other words, if less British coal were sent to Germany, the latter country would be compelled to use at home a larger quantity of its own production instead of exporting it. It is unfortunate that British coalowners have failed to recognise the importance of the weapon with which they have armed their commercial rivals, and which they are now strengthening month by month. Certain classes of users have to pay for the privilege of involuntarily supporting this reckless competition, and it is, perhaps, not going too far to assert that all consumers at home are being drawn upon to contribute heavily towards it at the present time.

### The Safety of American Railways.

ONE of the most striking proposals in the report of the Interstate Commerce Commission on American Railways, to which we refer on another page, is that a body with similar powers to our Board of Trade should be appointed to inquire into all railway accidents. The proposal must, of course, appeal to the English mind, but when we consider that something approaching two score of accidents occur daily in the United States, we cannot but feel that enormous difficulties present themselves. To deal with only the most serious of these accidents would mean a large staff. Such a staff could, no doubt, be found, but its members would not be of either the mental or moral calibre that is necessary if such inquiries are to be conducted on the lines of the British Board of Trade. It is to be feared that the proposed investigating officers would be drawn from railway servants, who, whilst excellent at their own particular work, are very departmental, often prejudiced, and either patronising or austere. In addition to this, it must be remembered that the railway companies are not likely to assist in the investigations. We should not expect to find any such cases as that in March last, where the Tralee and Dingle Company left a derailed engine *in situ* until the Board of Trade Inspector had seen it. But, supposing such difficulties overcome, would any good result, as long as American railroads are indifferent to blame, and even penalties, and the public are long-suffering and with short memories? The fact is that the real cause of the terrible record of disaster on American railroads—a record that gets worse year by year, notwithstanding improved facilities and more safety appliances, and out of proportion to the great increase of traffic—does not lie in the want of safety appliances, of the block system, of automatic couplings and continuous brakes, and so on, nor will the record be appreciably reduced should accidents be inquired into by an independent body. The need of American railroads is discipline and respect for orders. A recent issue of the *Railway Age* says on this subject:—"Reference to recently published statistics from various sources shows:—(1) That in the five years that the railways have made reports to the Interstate Commerce Commission over 70 per cent. of the serious collisions on American railroads have been due to the negligence of trainmen and enginemen; (2) that where serious collisions have occurred on lines protected by block signals 94 per cent. of these have been due to negligence of trainmen and signalmen; (3) that of all the train accidents in 1906 on the Erie Railway 95 per cent. could have been avoided had every employé concerned done his full duty." As long as men are not only indifferent to their reputations, but to their own limbs and lives, and those of their passengers, inquiries can do little good. Until discipline is enforced improvement cannot be expected.

### Port Authorities and the Future Development of Shipping.

THE discussion on Lord Pirrie's paper read before the Engineering Conference at the Institution of Civil Engineers last week did not elicit from the representatives of shipping interests and harbour engineers any definite forecast of what the future requirements of shipping are likely to be. All the speakers apparently avoided committing themselves to any definite statement of future policy, and Lord Pirrie himself, in his paper, gave no indication beyond the vague statement that we may rest assured that still larger ships will be built, and the increase will be stimulated by the provision of greater facilities in the direction he indicated. The only attempt to lay down a definite policy to be followed was that made by Sir Fortescue Flannery, who gave it as his opinion that future dock extensions and harbour improvements should be made with an increase of 25 per cent. on present limits in view. Obviously, this general statement cannot be followed to the letter, and it is impossible of application in many cases. Many harbour authorities following Sir Fortescue's advice, would find themselves burdened with immediate capital expenditure, hopeless of remunerative return. We fear such advice must be taken as a counsel of perfection. Sir William White's suggestion, that provision should be made in the future with especial reference to a large relative increase in the beam of ships, is well worthy of careful consideration, and, in connection with the rapidly increasing class of large cargo steamers, it is particularly important. The work that has been carried out in recent years at many of our home ports is worthy of all praise, and when we consider the conditions of such rivers as the Mersey, Clyde, and Tyne only a few years ago in comparison with what they are at present, the improvement is striking indeed. These three rivers will before long, it is hoped, have a minimum depth of 30ft. at low water in channels which fifteen years ago barely existed at that state of the tide. But besides providing a sufficient depth in the navigable channels, the question of increased dry dock accommodation has to be faced, and the construction of docks as large, or larger than, those recently made or about to be commenced at Liverpool, Southampton, and Belfast will have to be undertaken at other ports if harbour authorities and harbour engineers are to keep pace with the advance of shipbuilding. Another matter of importance was referred to by Lord Pirrie in his paper and by many of the speakers who took part in the discussion on it—that is, the attitude of the Admiralty in reference to the use of commercial dry docks by battleships. Generally speaking, hardly any commercial dock can accommodate a large modern battleship, owing to the special appliances and details of design necessary in docks intended for the latter class of vessel. Such accommodation could be readily provided in new commercial docks at a moderate additional cost; but it is obviously unfair to expect commercial undertakings to provide those special features unless the Government is prepared to assist in the cost. Hitherto the Admiralty have abstained from co-operation with harbour authorities in the matter; but there does appear to be scope for development in this direction, to the mutual advantage both of the Royal Navy and port authorities.

### Railway Companies and the Unions.

THE railway men who gathered in conference at Birmingham on Monday and Tuesday are to be congratulated on the temperate decision to which they came. The issue before them was practically peace or war. It was whether, as a protest against the determination of the railway companies not to

recognise the Amalgamated Society of Railway Servants as the official spokesman of all railway servants, they should hand in their notices. Against that course Mr. Bell very wisely persuaded them, and in the issue his advice was adopted by a very large majority. Had the belicose wishes of the minority carried the day trade and commerce would have been hopelessly disorganised, and the railway companies would, perhaps, have lost millions of money; but the men would have alienated public sympathy, and they would have deferred consideration of their claims to a far distant date. The trustworthiness of her railway servants is one of the things upon which Great Britain prides herself, and she is always ready to listen to any grievances they honestly have, and, as far as may be, to set them right. But in the present instance the grievance is of a very abstract and dubious kind. It is doubtful if the public would sympathise with it at all. There is no denial of the fact that railway servants who have complaints to make or concessions to ask can now approach their superior officers in succession, from the lowest to the highest, and probably the large bulk of the men are perfectly satisfied with this method of getting their cases heard. It is only the minority which wishes—and there is, of course, nothing unreasonable in their wish—to see their union recognised as an official mouthpiece which would settle all questions that lent themselves to such treatment on the principle of collective bargaining. The companies refuse to fall in with this proposal, on the grounds that the union does not represent a fair proportion of the men. That was the issue at stake at the conference, and it was practically on it that the question of strike or no strike turned. There was also the matter of increased wages, but that may be regarded as secondary, for the recognition of the union as spokesman for all the servants is the step which precedes the demand for higher wages. On this question of increased wages, the railways have said that they cannot afford to make the sweeping changes demanded, but they are prepared to consider every case on its merits. The result of the conference will be, no doubt, that Mr. Bell will again approach the companies, but no definite decision as to the next step of the men after their reply has been heard has been decided on. In the terms of the resolution, the Executive Committee are "to take such steps as they think necessary and the circumstances warrant."

## LITERATURE.

*The Naval Annual.* Edited by T. A. BRASSEY. 1907. J. Griffin and Co., Portsmouth.

THE twenty-first number of the *Naval Annual*, that for 1907, is as full of interest for those who are concerned in the welfare of our first great line of Imperial defence as any of the previous numbers, and the information contained in it is now far more systematically arranged and tabulated than it was at first, the contributors being men who are thoroughly experienced in the subjects that they handle. The illustrations, which are nearly all from drawings by W. Fred. Mitchell, are admirable as heretofore. The frontispiece, of the Dreadnought, is particularly good. Yet, when we come to details, and to portions of the work which refer to foreign navies and their recent units built and building, it is clear that exact information is becoming very difficult to obtain; and we can only be surprised that the editor has succeeded in putting together so interesting a volume. The fact that the authorities abroad have become chary of imparting information as to details of new construction leaves us in a state of uncertainty as to their progress. There have been rumours that they are building replies to our Dreadnought, but it is not known for certain that any ship of the Dreadnought type has as yet been laid down in any foreign dockyard; the French battleship Condorcet being the nearest approach to that vessel, but with a mixed armament very inferior in its battering power, whilst the Japanese vessel Satsuma is almost an exact reproduction of the Lord Nelson, and nothing is known of the German Ersatz Bayern, which is believed not to be even on the stocks. The two 20,000-ton monsters for the United States navy will, with their ten 12in. and fourteen 5in. guns, be very powerful vessels when they are built, but as yet their keels are not laid.

In Chapter I. many interesting particulars in regard to the battleship Dreadnought are quoted from an Admiralty memorandum. In it we observe that the "freeboard forward" is given as 28ft., the raised forecastle being included. This is hardly correct, for the forecastle is only a narrow solid unarmoured superstructure, giving no stability or stiffness to the vessel, and necessitating the carrying of the two great guns in the central barbette forward at the abnormal command of 32ft. or 33ft., in order to clear the deck when fired axially. The weight of these two guns in their elevated position, of the high barbette walls to protect their turntables, &c., and of the armoured hoods, all of which are well above the centre of gravity of the vessel generally, must be a great encumbrance to the behaviour of the Dreadnought in a sea-way. We find that "there is considerable difference of opinion in naval circles, British and foreign, as to the abandonment of all secondary armament in this vessel. On the one hand, it is claimed that the naval battles of the future, like most of those in the Russo-Japanese war, will be fought at long range, and at long range 12in. guns have an overwhelming advantage over those of smaller calibre. On the other hand, it is contended that the decisive engagements in the battle of Tsushima were fought at much shorter range than has sometimes been supposed, and that the 6in. guns played a very important part in deciding the issue of the battle. In the early actions of the war the Japanese were hampered by the consideration that the loss of a single battleship might involve for them the loss of the command of the sea." Hence the long range actions at first. The mixed armament to be adopted for the Condorcet and Satsuma types shows that the Japanese and French have no intention—at present, that is to say—of following the example given in the Dreadnought. The first named is to have four 12in. and twelve 9·4in. guns, and the Satsuma four 12in. and twelve 10in. guns; whilst, in addition, the Japanese ship is to mount twelve 4·7in. guns on the main deck. One possible reason which is suggested for this alternative arrangement is the rapidity with which the 12in. gun, with its abnormal battering charge of highly erosive propellant, loses accuracy after a limited number of rounds has been fired. This is a vitally important consideration. Nevertheless, it does not appear to us to be a sufficient reason for materially weakening the component elements of a ship's armament. Moreover, the possession of the greatest number of the heaviest guns gives the opportunity for occasional rests to each unit. If only four are carried, these would require to be continuously in action during an engagement. It is the want of rest which unduly heats a gun, and creates excessive erosion. It may, however, be remarked that future Dreadnoughts will probably carry a powerful secondary armament.

Three British armoured cruisers of 17,250 tons displacement have been laid down, and are being pushed on—the Invincible, Inflexible, and Indomitable. They are to have an armament of eight 12in. guns, a broad belt of 7in., with armour on the sides, and a speed of 25 knots. The editor of the *Annual* considers that "vessels of this enormous size and cost are unsuitable for many of the duties of cruisers;" but an even stronger objection to the repetition of the type "is the temptation for an admiral having Invincibles in his fleet to put them in the line of battle." A reference to the most recent range diagram, prepared by Mr. C. A. Hadfield, shows that the Invincible with her 7in. K.C. armoured sides must keep at 12,000 yards distance from her prospective enemy, to avoid being pierced by the guns of the latter if of 12in. calibre. Her great speed would give her advantage as to selection of opportunities for action, but it would be fatal for her to come to blows with a heavily-plated battleship, even of smaller tonnage. Her great size would rather be an advantage to the enemy, who, presenting a smaller target, and mounting 12in. guns, could attack her with impunity.

One of the most remarkable vessels being built for this country is the special destroyer Swift, at Messrs. Cammell and Laird's yard, at Birkenhead. She is of 15,000 tons displacement, 36 knots speed, and is to cost £280,509. As her coal supply is limited to 180 tons, she cannot be intended for ocean-going purposes, for the whole of her fuel would be exhausted in a few days even at a moderate rate of speed. She will, at any rate, be the fastest ship in the world, and the most expensive for her tonnage. Seven such ships would cost practically two millions.

Chapter VII., by P. A. Hislam, is a valuable commentary upon our position and that of Germany, as regards the strategical features of the North Sea, when compared with that of England and Holland in 1650 and a little later on. England and Holland then, like England and Germany now, were the chief competitors for the maritime trade of the world, though England did not then hold the leading position. In 1643 the merchant fleet of Holland consisted of 10,000 sail, manned by 168,000 seamen. England's fighting fleet was, however, stronger than that of Holland, although the disparity was not nearly so great as that existing between the navies of Germany and Great Britain at the present day. The outstanding feature of the events which subsequently occurred between Holland and England is the immense benefit which accrues to Great Britain by reason of her geographical position. As in 1643, so at the present time, with the exception of the comparatively insignificant traffic with the Baltic, every stream of our neighbour's commerce must concentrate near and pass along the shores of Great Britain. Hence, in the unlikely event of troubles arising with Germany, the main factor of the position is the absolute control which Great Britain, thanks to her geographical situation, holds over every trade route leading into the North Sea. To Germany a war with Great Britain means commercial extinction. But the concentration of our fleet in home waters has been a step of the utmost, importance in order to secure the advantages of our natural position.

Excellent papers on the "Blue Water School," by Mr. John Leyland, advocating concerted arrangements between a sea-going navy and a ready-for-sea-going military force prepared at any moment to strike when and where necessary; also a valuable contribution by Captain Chas. N. Robinson, R.N., on "The Laws of the Navy," as well as a series of interesting treatises upon British and foreign naval manœuvres, by Mr. T. R. Thursfield and Mr. John Leyland, are included in this volume; but our space is, unfortunately, too limited to take them up. A valuable contribution upon "British Shipbuilding Programmes," which strongly advocates the giving of as much work as possible to our private shipbuilding yards, so as to encourage their enterprise, is also well worth reading. That on "Naval Reorganisation" will be read with interest by naval officers.

The plates of British and foreign ships are, as usual, full of interest for the naval architect. Those of the French battleship Condorcet should in particular be carefully studied.

## RAILWAY WORKING RESULTS.

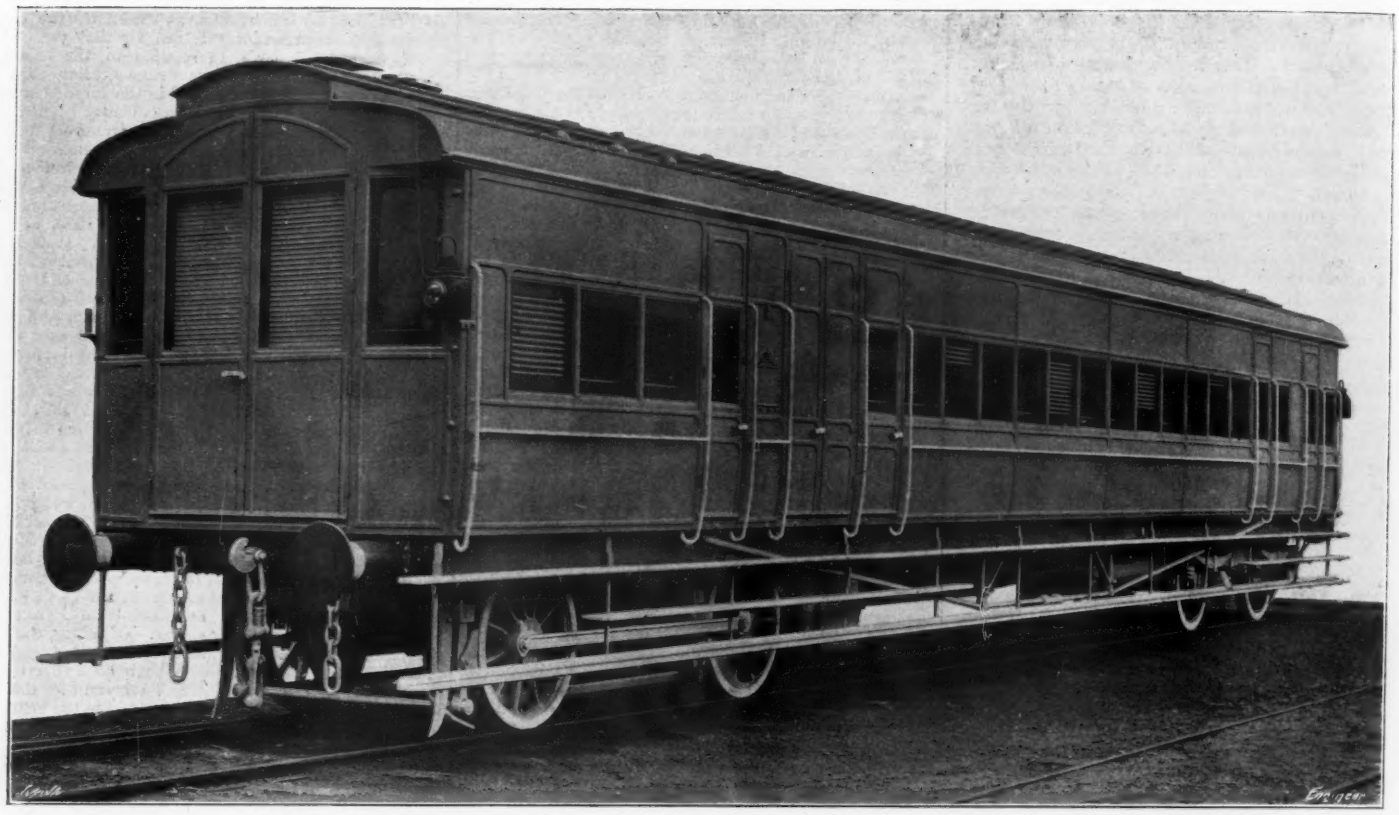
IT was to be expected that the upward movement in most branches of trade in the United Kingdom during 1906 would exercise a favourable influence upon the working results of the railways, and the anticipation in this respect has been justified by the results, as shown by the figures embodied in the preliminary return for that year. This fact is illustrated both in relation to the passenger and the goods traffic; thus demonstrating that the working classes have participated in the improvement in the trade of the country, and consequently been able to avail themselves more largely of the transport facilities afforded by the railways. Indeed, some remarkable displacements are noticeable in the passenger traffic. The number of first-class passengers, which increased by 1,400,000 in 1905, as compared with the preceding year, underwent a diminution of 800,000 in 1906, and the second-class traffic also declined last year. It is highly probable that the reduction in first-class travellers is only apparent, and that the particular number concerned have been transformed into holders of season tickets, seeing that the latter increased largely in 1905, and made a further advance of 30,000 in 1906. In the case of the second-class traffic the shrinkage assumed enormous dimensions, the diminution having amounted to no less than 10,000,000 as contrasted with 1905, which in turn exhibited a decrease of 18,000,000 as against 1904. It is, however, important to observe that the falling off in the past two years is largely due to the practical abolition of the second-class on the Metropolitan and District Railways, and, in addition to this, the passengers carried by the Liverpool Overhead Railway have been included as first or third-class in the totals for 1905 and 1906, instead of first and second class as in former years. The third-class traffic, which continues to be the backbone of the passenger business, both numerically and financially, experienced the phenomenal augmentation of 52,000,000 over 1905, which itself manifested an advance of 18,000,000 over the preceding year. Of course, the great progress of the third-class traffic includes the large number of second-class passengers who have been diverted for the reasons already given. The final result for the year is the satisfactory increase of 41,000,000 in the aggregate number of passengers carried, and of £1,100,000 in the gross receipts from this source.

The diminution in the train mileage of the goods traffic which has been such a remarkable feature in recent years has been brought to a stop by the working results for 1906. As will be seen on reference to our issue of June 8th, 1906, we ventured to suggest that a limit was being reached in the economical working of goods and mineral trains. This assumption was arrived at from the fact that the decrease in 1905 was comparatively slight, whereas in the three or four years immediately preceding the reduction in the mileage of the goods trains was of considerable extent. How correct our assumption was is now shown by the ascertainment that we once again have an increase in the goods train mileage of no less than 4,000,000, although this is coincident with an advance of 27,000,000 tons in the quantity of minerals and merchandise carried. As, however, the similar traffic in 1905 was 11,000,000 tons greater than in the preceding year, and, at the same time, was handled with a reduced train mileage of nearly half a million miles, it would seem that it has not been possible to work the additional traffic in 1906 on such an economical basis from the mileage point of view. The operation of the passenger train service, as might be expected, followed in the same path as in former years by making a fresh development. In 1905 the passenger train mileage was slightly over 4,000,000 in excess of the previous twelve months, whereas the figures for 1906 indicate the formidable progress of over 9,000,000 train miles. The final result for the year is represented by a gain of £939,000 in the net receipts of all the railways combined from both passenger and goods traffic, this comparing with an increase of £800,000 in 1905, as contrasted with the preceding year.

The conclusion to be drawn from the statistics is that 1906 was a satisfactory year to the railways regarded as a whole. In considering the figures it has to be borne in mind that the length open for traffic in 1906 was 227 miles in excess of the previous year, and that the share capital increased by fourteen millions sterling. As far as the augmentation in the mileage is concerned, it is obvious that this small addition can only have contributed slightly towards the considerable advance in the passenger train mileage during the year. The greater portion of the larger train mileage is doubtless due to the additional facilities which the railways placed at the disposal of the travelling public, and the element of competition between the railways themselves and between the railways and tramways and motor omnibuses in some districts, has also played a part in forcing up the mileage of the passenger trains Very little has recently been heard of working arrangements between the railways as regards passenger traffic, but from the public point of view it is preferable for the existing state of competition, where it actually prevails, to continue without interruption. Indeed, it is probable that an adherence to the present system of friendly rivalry will cause the passenger train mileage to increase year by year, and thus be of advantage to the public, if not to the shareholders. As it is, the large augmentation in the mileage of both passenger and goods trains in 1906 has brought about a considerable increase in the working expenses, which attained a higher proportion than in 1905 or 1904. Locomotive power or the coal bill absorbed in 1906 a much larger sum than in the previous year, and the excess was, in fact, nearly as large as the total increase in the net receipts from both the passenger and goods traffic, as already mentioned. The maintenance of way, works, &c., also necessitated a larger outlay, and if traffic expenses are to be read as the cost of labour, the amount paid under this heading was £465,000 higher than in 1905.

# STEAM RAILWAY MOTOR COACH—EAST INDIAN RAILWAY

NASMYTH, WILSON AND CO., LIMITED, PATRICROFT, ENGINEERS



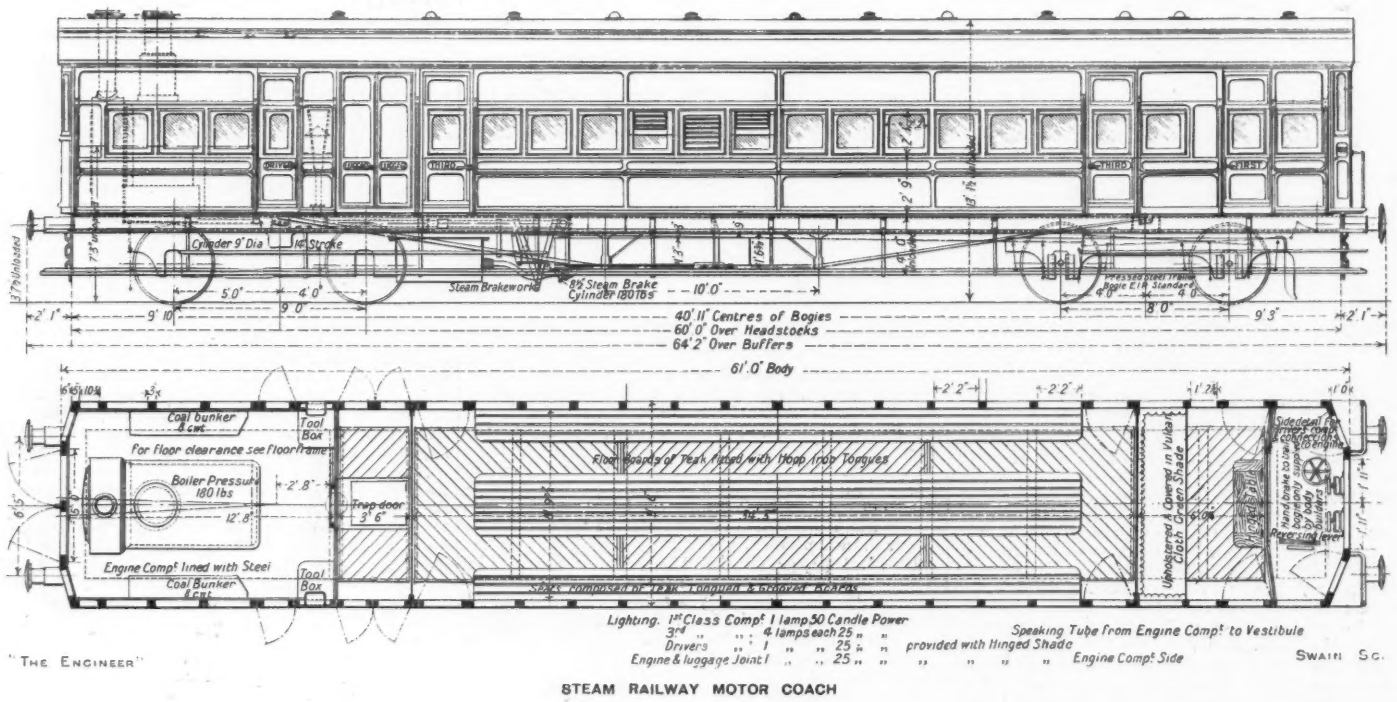
## STEAM RAILWAY MOTOR CARRIAGE FOR INDIA.

A BATCH of self-propelled railway cars has been ordered by the East Indian Railway Company from the firm of Nasmyth, Wilson and Co., Limited, Patricroft. They are built according to the specification of Messrs. A. M. Rendel and F. E. Robertson, of 8, Great George-street, Westminster, and are intended for employment on sections of the above railway from two to 51 miles long. The gauge of the line is 5ft. 6in., and there are curves to be met with of 500ft. radius. As will be seen by the illustrations below, they are divided for two classes of passengers, and a separate compartment is provided for luggage. The vehicles have to comply with the following rules as regards measurement:—

| | |
|---|---|
| Maximum width— | |
| From rail level to a height of 4ft. 4in. above rail level | 10ft. |
| From 4ft. 4in. above rail level to 8ft. 3in. above rail level | 9ft. 6in. |
| From 8ft. 3in. above rail level to 11ft. 6in. above rail level | 10ft. 6in. |
| Max. width over open doors, including all projections— | |
| For passenger vehicles | 13ft 3in. |
| Max. height from rail level— | |
| For unloaded vehicle at centre | 13ft. 6in. |
| " " sides | 11ft. 6in. |
| Weight on a pair of wheels— | |
| Maximum | 9 tons |
| Buffers and couplings— | |
| Standard distance apart for centres of buffers | 6ft. 5in. |
| Max. height above rail level for buffer centres, unloaded | 8ft. 7½in. |
| Max. height above rail level for buffer centres, loaded | 8ft. 4½in. |
| Height for floors, 4ft. 4in. unloaded and 4ft. 1in. loaded | |

The vehicles are completely enclosed from rear to front, and can be driven from either end, and are 60ft. long over headstocks. The underframes are of steel channel bars, plates and angle bars, and are made in two lengths for convenience of shipment. The carriage bogie trucks are made of pressed steel plates, and are fitted with a hand brake worked from the vestibule, with two brake blocks on each wheel. The whole of the woodwork, including the framing, floor, roof, and lining boards, doors, window-frames, &c., is of Moulmein teak. The body is lined throughout with teak matchboarding, and fitted with teak seats. The upper portions of the sides and partitions and the roof of the first and third-class compartments are to be lined with Linerusta Walton backed with millboard when re-erected in India. The lower portion of the interior of the engine compartment is lined with steel plates, and steel floor-plates are also provided, provision being made in the roof for the chimney and safety valves.

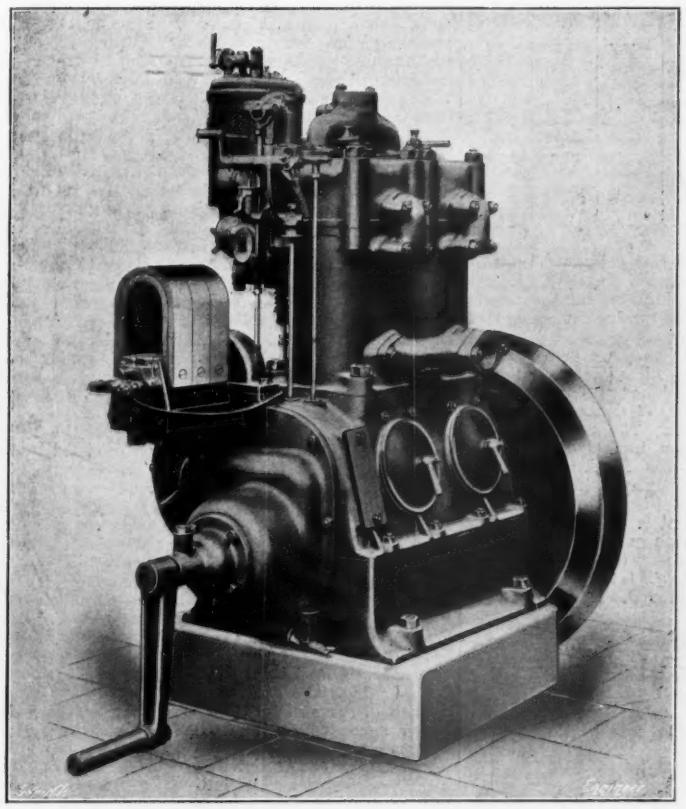
Steel protector plates are fitted round these parts. The body contract was sub-let to the United Electric Car Company, Preston. The boiler is intended for a working pressure of 160 lb., and has a heating surface of 322·5 square feet. This is made up as follows:—Tube surface, 279·5 square feet; fire-box, 43 square feet. The grate area is 7·5 square feet. The boiler shell is 3ft. 7in. internal diameter, is 3ft. 6in. long, and contains 225 tubes 1¾in. diameter. The fire-box, fire-box stays, and rivets are of copper. The engine has two inside cylinders, 9in. by 14in., and the valve gear is of the Walschaert's type. The drive is taken by the rear axle, and the wheels are coupled by outside coupling rods. Several water tanks are provided, the centre tank holding 184 gallons; the two side tanks, 96 gallons each; and the coach tank, 220 gallons, giving a total water capacity of 500 gallons. The design of the vehicle is based on that of Mr. Whale, of the London and North-Western Railway, the boiler being mounted on the engine bogie and enclosed in the car body. The body at this end has large doors, and provision is made for detaching the headstock, the end bar of the body, and the end portion of the flooring; so that when the main underframe is lifted sufficiently to disengage the bogie centre, the bogie, with engine and boiler, can be run clear of the carriage for repairs, &c. The headstock at the engine end is attached to the sole bars by means of cast steel knees and

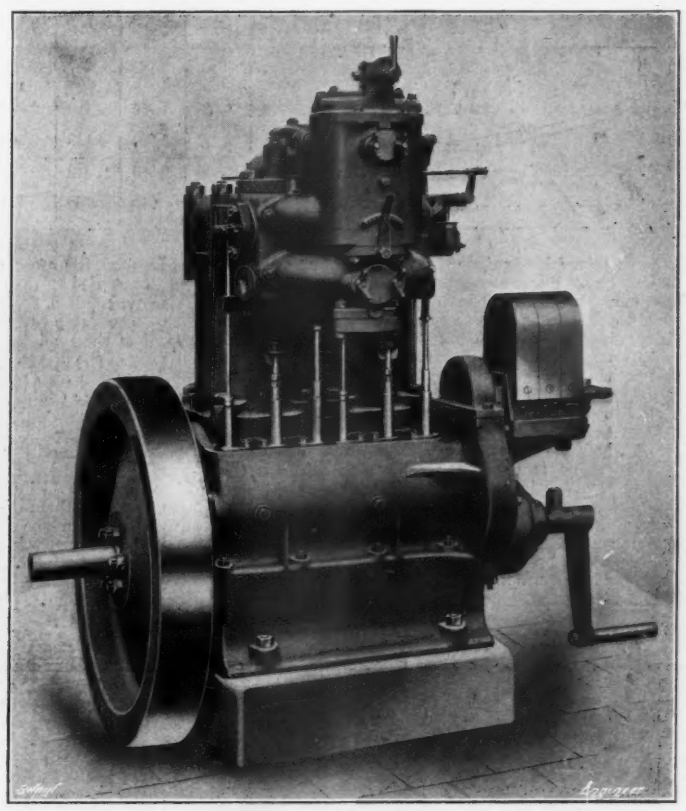

Cylinder 9" Dia
14" Stroke
Steam Brakework
8½" Steam Brake Cylinder 180 lbs
Pressed Steel Bogie E.I.R. Standard
40' 11" Centres of Bogies
60' 0" Over Headstocks
64' 2" Over Buffers
61' 0" Body
Coal bunker & cwl.
Tool Box
For floor clearance see floor frame
Boiler Pressure 180 lbs
Trap door 3' 6"
Engine Compt lined with Steel
Floor Boards of Teak Fitted with Tongued Joints
Upholstered & Covered in Vulcanite Cloth Green Shade
Lighting. 1st Class Compt 1 lamp 50 Candle Power
3rd " " 4 lamps each 25 " "
Drivers " 1 " " 25 " " provided with Hinged Shade
Engine & luggage Joint 1 " " 25 " " " " " " Engine Compt Side
Speaking Tube from Engine Compt to Vestibule
"THE ENGINEER"
SWAIN SC.

STEAM RAILWAY MOTOR COACH

## INTERNAL COMBUSTION ENGINE AT THE ROYAL SHOW

CROSSLEY BROTHERS, LIMITED, MANCHESTER, ENGINEERS





bolts. These knees are arranged to come away with the headstock when the latter is removed. Provision is also made for clearance to allow of side movement of the boiler when traversing curves of 500ft. radius. Combined steam and hand brakes are provided for operating on all the engine wheels, and there is also hand-sanding apparatus. The wheel centres of the engine bogie are of cast steel, with oval section spokes. Provision is made for working the regulator, reversing gear, steam brake and whistle both from the engine compartment and also from the vestibule at the other end of the vehicle. A hand brake in the vestibule is also provided for operating on the bogie wheels, there being two blocks on each wheel. The carriages are fitted throughout with a complete system of Pintsch's inverted incandescent gas lamps. The engravings on pages 646 and 656 give details and perspective views respectively of the engine which is fitted to these coaches.

## ELECTRICITY FOR LONDON.

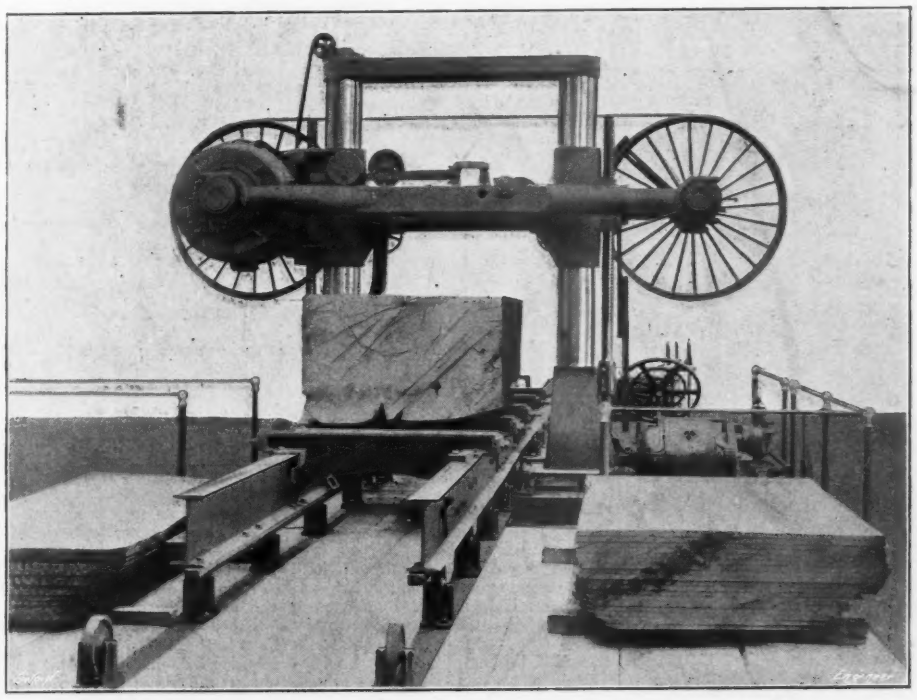
THE Hybrid Committee of the House of Commons, which for the last fortnight have been considering the London County Council Electric Supply Bill, on Wednesday last found the preamble not proved, and the Bill was accordingly thrown out. It will be remembered that in the original Bill as brought in by the late Council, it was sought to obtain powers to supply electricity in bulk for power purposes throughout an area embracing, not only the County of London, but a large surrounding district, including populous places like West Ham and Croydon. The present Council determined to go on with the Bill, but to amend it in such a way that while the powers were to be vested in the Council, it was proposed to lease them for a period not exceeding fifty years on terms and conditions to be approved by the Board of Trade, but the Council was to have control and supervision of the supply over the whole area. Several borough councils which own electrical undertakings and various electrical companies petitioned against the Bill, on the ground that the Council's scheme was likely to compete prejudicially with existing concerns. After a prolonged cross-examination of the witnesses called in support of the Bill, the case for the promoters was concluded last week. Several more sittings would have been occupied with the case for the various petitioners, but early on Monday the proceedings were suspended in order that the Committee might confer in private, with the result that yesterday morning, Mr. D. A. Thomas, the chairman, announced that the preamble had not been proved, and that the Committee would report accordingly to the House.

DAMAGES FOR INFRINGEMENT OF PATENT.—In a recent case before Mr. Justice Kekewich an action was brought for infringing the patents of certain motor accessories. There was only one motor in which the infringing articles were used. The defendants practically "pleaded guilty," and paid £20 into Court as damages. The Court, in the first instance, fixed the damages at £10. The plaintiffs contended that this was insufficient, alleging that they should receive the sum which they would have received on the sale of a motor car with the accessories in question. They claimed, therefore, £141. Mr. Justice Kekewich, however, said that this was not the right principle. He pointed out that the question was, "What would have been the condition of the plaintiff if the defendants had acted properly instead of improperly?" The measure of the plaintiff's loss was commensurate with the defendants' gain. They bought a car with the accessories in question, and it must be taken that those accessories were valuable. The Court, therefore, had to ascertain the difference between the value of the car with the accessories and its value without them. That was the measure of damages.

## THE ROYAL AGRICULTURAL SOCIETY'S SHOW.

THE Royal Agricultural Society is justified on several grounds in selecting Lincoln as the place to hold its 1907 show. Lincoln, apart from the attractions it offers as an ancient cathedral city, is the centre of a large agricultural district, and its association with the implement industry dates back probably as far as the Society itself. The names of quite a number of the most prominent firms engaged in the building of implements of agriculture suggest themselves to engineers at the mention of the name of Lincoln. For instance, there are Clayton and Shuttleworth, one of the first builders of portable steam engines; Robey and Co., W. Foster and Co., Ruston, Proctor and Co., and others; and it is worthy of being placed on record that the site of the 1854 show is now occupied by the works of Messrs. Robey. Since the Royal Agricultural Society was founded, sixty-seven annual shows have been held, with only one break caused by a cattle plague in 1866. Forty-two different provincial towns have received the Royal Show, four of them —Newcastle, York, Carlisle, and Derby—on three occasions; fourteen of them twice—excluding Lincoln, which is now visited for the second time—and twenty-two of them once.

In addition, five shows have been held in the metropolis, viz., at Battersea in 1862, at Kilburn in 1879, and at the ill-fated Park Royal in 1903, 1904, and 1905. The earlier shows were noteworthy for the different implement trials, which no doubt had much to do with fixing the designs of the chief implements now in use. The previous visit of the Society took place in 1854. At this meeting the value of the prizes offered was £1510, as compared with a sum of over £8500 this year, a sum which has only been exceeded on two occasions, namely, at Kilburn in 1879, and at Windsor in 1889. It is worthy of record that the Farm Prize competitions have this year been revived, and prizes amounting to £300 have been offered for large and small farms in Lincolnshire. It says much for the popularity of the revival that no less than 183 entries have been received in this competition. In all departments the entries have been very large, and worthily



RANSOME'S ELECTRICAL LOG BAND SAW

maintain the best traditions of the Society. The following figures refer to the implement section:—

*Shedding in Implement Yard.*

| Description of shedding. | Lincoln, 1907. | Derby, 1906. | Park Royal, 1905. | Park Royal, 1904. | Park Royal, 1903 | Carlisle, 1902. | Cardiff, 1901. | York, 1900. | Lincoln, 1854. |
|---|---|---|---|---|---|---|---|---|---|
| | ft. | ft. | ft. | ft. | ft. | ft. | ft. | ft. | ft. |
| Ordinary ... ... ... ... ... ... ... ... ... ... | 7,650 | 7,818 | 6,590 | 7,630 | 9,360 | 6,693 | 7,245 | 9,454 | — |
| Machinery... ... ... ... ... ... ... ... ... ... .. | 2,165 | 2,520 | 1,750 | 2,060 | 2,670 | 2,079 | 2,305 | 2,547 | — |
| Special (seeds, models, &c.) ... ... ... ... ... ... | 3,251 | 2,692 | 1,629 | 2,032 | 2,555 | 2,321 | 2,101 | 2,771 | — |
| Total, exclusive of open ground space ... ... | 13,066 | 13,030 | 9,969 | 11,722 | 14,585 | 11,093 | 11,651 | 14,772 | — |
| No. of stands ... ... ... ... ... ... ... ... ... | 417 | 424 | 289 | 350 | 456 | 340 | 358 | 412 | 131 |

The showyard is situated on the West Common, inside the Carholme Racecourse, and covers an area of 125 acres, being larger by about 45 acres than the site on which the Derby Show was held last year. The main entrance is at the south end of the ground, facing Alderman's-walk, with approaches from Carholme-road and West-parade. Entering the city from the Great Northern Station, the visitor is early reminded of the position which Lincoln occupies in the agricultural implement world by two huge triumphal arches, on the top of the first of which a very creditable large sized model of a portable engine is perched. Below the model is the inscription, "Lincoln's Wealth." On the second arch an equally effective large model of a thrashing machine is placed, and under this the inscription, "Lincoln's Fame." Both arches are highly appropriate, and are suggestive of the decorative uses to which other mechanical appliances may be applied for similar occasions. The Horticultural Exhibition, which was a prominent feature at Derby last year, is being carried out at Lincoln by the Lincoln local committee, and its proportions have considerably exceeded those of the 1906 Exhibition, the entries necessitating the provision of twice the amount of space required at Derby. The Forestry Exhibition this year has an added interest, in view of the fact that special medals in silver and bronze are offered for competition in fourteen different sections, including classes for specimen boards of various sorts of timber, specimens showing the damage done by insect pests, the comparative quality of timber grown on different soils, and the respective ages at which it reaches marketable size, and the beneficial effects of pruning when well done and the injurious effects when badly done. The information thus disseminated cannot fail to be of service.

The Exhibition opened on Tuesday last in bright but doubtful weather, and before the day was completed rain set in in a fashion which rendered viewing the implement yard a toilsome proceeding. Competitions in the implement section were this year confined to swath turners and side delivery hay rakes. The competitions took place prior to the show, and the results were published on Tuesday. For swath turners the first and second prizes were awarded to Messrs. Blackstone and Co., Limited, Stamford, and for side delivery rakes this firm also carried off the chief honours, Martin's Cultivator Company, Limited, Stamford, being awarded the second prize. The swath turner has two turning devices carried in front of the road wheels, so that the work done is in full view of the driver, by whom they can be controlled. The driver can also reverse the direction of rotation of the tines, which enables the machine to follow a mowing machine having a right or left-hand cut, and can work with the wind favourable to him. The machine is also able to work in either direction, instead of having to travel one way idle. The tines of the Blackstone machine are not rigidly held by the driving apparatus, but have play to allow them to adapt themselves to uneven surfaces. When the implement is travelling forward the tines get beneath the swath and lift it from the ground, and by a lateral motion carry it to the side, where by means of a "feathering" motion it is turned completely over and left on a dry piece of ground. By means of the reversing motion provided the driver can set the machine to collect two or three rows into one row in one operation, and by means of the expanding axle can collect four rows into two rows. The side delivery rake has a number of tines similar in shape to those of a horse rake. These tines are carried on horizontal chains travelling across the line of draught, and at the end of their travel lifting vertically out of the crop, while a feathering motion places the crop in an open windrow at the side. The motion of the implement may be instantly reversed, and the crop delivered on either side.

RUSTON, PROCTOR PORTABLE ENGINE

A complete portable sawing plant for converting timber in forests is shown in operation by A. Ransome and Co., Limited, Newark. The chief feature of the plant is a self-contained electrically driven horizontal log band saw shown on page 661. In this machine, which is capable of converting logs 36in. diameter, the armature of the motor is built round the axle of one of the saw pulley shafts, thereby obviating the use of belting and gearing. Another advantage claimed for this direct electric drive is that the space occupied by the machine is reduced to less than half of that which would be required for a belt-driven machine, and this mode of driving enables the machine to be placed in any position that may be found most convenient without regard to the position of the main shaft in the mill. The whole of the working parts are carried on a bed-plate which is fixed on the ground level, thus saving costly excavations and masonry foundations required for a vertical saw frame. The machine is so well balanced that although the saw is running at more than a mile a minute, and although it is simply placed on a few sleepers which are bedded in the ground, the machine works without vibration. The various motions of the machine are controlled by one man, while two labourers remove the boards as they are sawn from the log. The pulleys which carry the saw blade are 5ft. diameter and 6in. wide, the driving pulley being somewhat heavier than the one that is driven. The saw blade runs on the metal rims, being shaped slightly to fit the convex surface of the rim. The saw pulleys are fitted on steel shafts running in ball bearings, and the tension is regulated by levers and a small weight. The tension may be varied by shifting the weight along a horizontal lever. The casting on which the saw pulleys are carried rises and falls on two cast iron columns, the vertical movement being actuated by two strong square threaded screws made to rotate in either direction by gearing. The speed at which the saw is automatically lowered can be varied by simply moving a hand lever, and when sawing boards from the log the blade can also be lowered after each cut to suit the thickness of board by turning a large hand-wheel shown.

The saw is supported on each side of the log by passing through adjustable hardwood guides, carried in brackets, depending from the main saw carriage. The travelling table, which carries the log, is constructed of rolled-steel girders of a strong section, connected by cast iron stretchers. The carriage runs freely on a series of turned rollers revolving in carriages screwed to the floor. Each of the cast iron stretchers is provided with two wrought steel dog cramps worked by screws from either side of the carriage. The dogs, which are adjustable as to height, are so constructed that the action of screwing them into the log also sets them fast in their sockets, and thus, if the timber has a tendency to spring when partly converted, the dogs being set fast in their sockets prevent it from rising. The dogs are dropped into one or other of a series of square holes formed in long cast iron nuts, which saves considerable time in securing logs of various sizes. The carriage is run backwards and forwards by means of two wrought steel pinions with machine-cut teeth working into corresponding racks under each main side girder. The feed, which ranges from 4ft. to 80ft. a minute, is driven by an arrangement of friction gear controlled by a switch handle, by which the operator can instantly vary the rate of advance of the log, changing from the slowest to the fastest, or any intermediate speed. The backward motion of the carriage is also worked by friction gear, and is operated by another lever. The sawyer, who stands in front of the machine, has its entire control immediately within his grasp by means of four levers, mounted in a switch rack, which operate all the different motions.

We are informed that the rate of cutting ranges up to as much as 100 superficial feet of sawing a minute in elm and other similar woods, and the waste of wood in the saw cut is so small that a log 3ft. square converted into ¼in. boards with the saw yields eight boards more than could be obtained from it if sawn with either a vertical frame or a horizontal reciprocating saw.

The electric current required to drive the machine averages as nearly as possible one Board of Trade unit for every 100 superficial feet of sawing.

The firm of Ruston, Proctor and Co., Limited, Lincoln, has a very imposing exhibit, including several features of novelty. One of these, shown on this page, consists of a 10 nominal horse-power portable engine fitted with a new form of superheater, which is placed in the smoke-box and can be shut off from the boiler and cylinder. The gases may be directed by means of a simple baffle plate, either through the superheater or direct into the chimney. In this way the apparatus can be put out of action when raising steam, nor does its addition interfere with the accessibility of the boiler tubes for cleaning purposes. The engine has a piston valve, a shaft governor on a single excentric, a simple feed-water heater, and an oil separator, shown, and ring lubrication for the bearings. The superheat used does not exceed 100 deg. Fah.

The implements and engines shown by Clayton and Shuttleworth, Limited, are chiefly of the firm's standard patterns. One of the most recently introduced engines is a light steam tractor, which has been designed to comply with Local Government Boerd regulations. The engine is compound. The feed pump, instead of being actuated direct from the crank shaft, as formerly, is now driven by gearing. The speed of the pump is thereby reduced, thus minimising wear. The boiler is stayed to withstand a working pressure of 180 lb. per square inch. The hind axle is spring mounted, whilst the fore-carriage is of substantial design, laminated springs being provided to carry the engine, the whole being supported by an improved form of stay. The main road wheels are of unusually large diameter.

Two large thrashing machines are shown by Clayton and Shuttleworth, embodying several minor improvements. One of these is 54in. wide, with new patented drum 22in. in diameter, new type of shakers, new cavings riddle, dust exhauster, chaff-sifting apparatus, and oil lubricators. The other thrasher is 60in. wide, with new 22in. drum, double crank shakers, grease lubricators, and is mounted on iron wheels. This machine is also fitted with adjustable cavings riddle consisting of a series of stamped steel strips, which can be opened and closed like louvres by means of a hand wheel and screw. There is also a new arrangement fitted for adjusting the barley awner. The awner beaters and casing are conical, and by means of a screw the amount of clearance between the two can be regulated.

Robey and Co., Limited, Lincoln, are represented by portable and fixed engines and locomotives and a motor

wagon. The chief features of the latter are well known to our readers. The road locomotive exhibited is a compound, of 8 nominal horse-power, the high-pressure cylinder being 6½in. diameter and the low-pressure 11in., with a stroke of 12in. The engine is mounted on the Robey spring gear on the back axle, which we shall illustrate in a future issue, and it is also spring mounted on the front axle. A front water tank is provided, and ample water and fuel capacity is arranged for in the tender. The motion work of the engine is enclosed by side covers, and the gearing is also encased. Their standard type of drop-valve engine is represented by a horizontal fixed engine with a cylinder 17in. diameter by 36in. stroke, and a smaller engine of the same type. The admission of the steam is controlled by the well-known automatic drop valve gear. The portable engine department is represented by an 8 horse-power single-cylinder and a 20 horse-power double cylinder engine. The traction engines exhibited are of 7 and 8 horse-power respectively, and contain several improvements in design. All the main details of the engine are mounted upon special steel seatings, these seatings being riveted to the boiler. The result of this arrangement is that no bolt heads are in the steam space of the boiler, and the nuts are so arranged that all can be got out without even disturbing the lagging, and all the steam joints being visible, attention can easily be given to these, should occasion require it. These engines have the arrangement of spring mounting on the back axle above referred to.

A new type of internal combustion engine is shown by Messrs. Crossley Brothers—see page 661. It is a vertical two-cylinder high-speed engine intended to use paraffin, petrol, alcohol, or gas as fuel. The engine is designed to give 10 brake horse-power at 700 revolutions per minute. The cylinders have loose liners and the cranks are balanced. The vaporiser is heated by the exhaust gases, and the supply of mixture from the vaporiser to the main engine valves is controlled by a valve whose movement is damped by a spring. When running with no load the exhaust gases are allowed a free passage to the vaporiser, but when running under full load these can be throttled. A low-tension magneto apparatus is provided, and the timing of the ignition can be regulated to suit requirements in an ingenious manner.

We shall refer to a number of other interesting exhibits next week.

## THE FRENCH INDUSTRIAL VEHICLE TRIALS.

THE efforts which French automobile firms are making to secure a share of the growing trade in industrial vehicles are meeting with success, to judge from the way in which some of the wagons and omnibuses behaved in the particularly severe trials that have just terminated in Paris. The great drawback which French builders have had to contend with is their imperfect knowledge of the conditions that have to be fulfilled by industrial vehicles, due principally to the fact that this branch of the industry has been overshadowed by the purely pleasure type of vehicle to a greater extent, perhaps, than in any other country. While makers had as much as they could do to supply the needs in touring cars, they were not disposed to go in for the construction of a class of vehicles which not only necessitated an entire departure from their usual practice, but was distinctly precarious and less profitable. When, therefore, wagons were required, they simply put platforms and omnibus bodies on standard chassis, with the result that the high running costs and the upkeep very soon brought the industrial vehicle into disrepute. The heavy production of the French motor car industry, however, has so far changed the situation of makers that many of them have found it advisable to specialise themselves in industrial vehicles, in which they have been encouraged by the success of this branch of the industry in England and Germany, as well as the growing demand in France for suitable wagons and public service vehicles. The military authorities are also taking the keenest interest in everything relating to motor traction, and it was because the trials organised by the Automobile Club of France were taken in hand by the military commission that they were regarded as of more than ordinary importance. It was the first time that trials of heavy cars had been carried out in France upon what may be called a scientific basis.

The conditions of the test were simple enough. The vehicles had to run twenty consecutive days over average distances of sixty and a hundred miles per day, according to the class. A minimum average speed for each class of vehicle was fixed, as well as a time limit for reaching the controls. A vehicle which did not arrive within this time was pitilessly disqualified. For two weeks the wagons and public service vehicles went over circular routes radiating round Paris, and on the last few days they made a tour through the northern departments by way of Amiens, Lille, St. Quentin and Compiègne. The vehicles that were left in the trials took part in a final consumption test upon which the classification was based. Simple though the trials were, it is difficult to imagine anything more severe, for every part of the wagon was marked and sealed, so that there could be no repairs and no means even of opening the gear box or crank chamber, or of getting at any of the internal parts of the engine. It meant that the wagon had to run something like 2000 miles over all kinds of roads and in all weathers, with a load usually in excess of that for which it was designed, without any possibility of adjustments or repairs. No fewer than forty-one vehicles took part in the trials. The wagons and vans were divided into four different categories according to the loads carried, while there was a separate class for public service vehicles and another for motor cabs which had to run with alcohol. Seeing that the final classification was to be based upon the cost of the fuel consumed, it was obvious that competitors had every advantage in employing the cheapest form of liquid fuel available, and it was hoped that the trials would throw a good deal of interesting light upon the suitability of cheap oils for industrial vehicles. Only one competitor, however, tried to offer a solution of the fuel problem by running some of his vehicles with naphthaline, for which a special type of vaporising device is used, whereby the crystals are first of all introduced into a hot liquefying chamber and then vaporised and mixed with the required proportion of air. This exceedingly cheap fuel was tried in some French cars a few years ago, with fairly encouraging results, and in the heavy car trials which terminated last week some of the Eugène Brillié wagons ran with at least sufficient regularity to lead to the belief that something may ultimately be done with cheap fuels of this kind, although the troubles with the naphthaline vaporiser were partly responsible for the failure of the vehicles to reach the controls within the stipulated time. The other Eugène Brillié vehicles ran with alcohol, as did also the motor cabs, but all the other competitors employed petrol, with the exception, of course, of the Darracq-Serpollet cars, in which steam was raised by heavy oils. So far as the general design of the vehicles is concerned there is nothing calling for special mention, as nearly all of the wagons were of well-known types that offered very little departure from standard design. The only feature of interest, apart from the question of fuel, was the behaviour of the wheels and tires. The French makers have always shown a prejudice against the steel tired wheels, in the belief that the wear and tear of the mechanism incidental to rigid tires and wheels far outweigh any expenditure upon rubber tires, but so far as the economy of tire upkeep is concerned, it does not appear as if the trials bore out these conclusions. There was little opportunity of testing the comparative merits of steel and rubber tires, because only two wagons were running with steel tires, and both failed to go through the test. As was to be expected with the heavy loads carried and the speeds at which the vehicles were driven during the early part of the trials, when the Minister of the Interior was obliged to issue a warning that if the legal limit of speed were exceeded the competitors would suffer heavy penalties, quite a large proportion of the wheels gave way. This was particularly the case with the spring wheels, which were very soon eliminated, and the only type of wheel that gave really satisfactory results was one in which provision is made for taking up any looseness by forcing the spokes between the hub plates by means of nuts. Of the 41 vehicles competing only 12 succeeded in qualifying for the final consumption test. This took place over a circular course around Paris, when the results were obtained by a formula in which the time occupied for the journey in hours and the consumption of fuel in francs was divided by the distance in kilometres and the load. The cost of petrol and alcohol was estimated at 33·25f. per 100 litres, and heavy oils at 18f. per 100 litres. The results were as follows:—Second category: Delahaye, 1443 kilos. load, 0·0726f. per ton-kilometre; Ariès, 546 kilos. load, 0·1424f. per ton-kilometre. Third category: De Dion-Bouton, 3040 kilos. load, 0·042f.; Darracq-Serpollet, 2795 kilos. load, 0·039f.; Darracq-Serpollet, 2793 kilos. load, 0·041f.; Turgan, 2900 kilos. load, 0·043f.; Panhard-Levassor, 2403 kilos. load, 0·044f. Fourth category: De Dion-Bouton, 3040 kilos. load, 0·042f.; Darracq-Serpollet, 3528 kilos. load, 0·043f.; Darracq-Serpollet, 3530 kilos. load, 0·045f.; Mors, 3013 kilos. load, 0·048f. Fifth category, omnibuses: Eugène Brillié, 1500 kilos. load, 0·072f.; Ariès, 822 kilos. load, 0·088f. per ton-kilometre. The trials cannot be said to have proved much beyond the reliability of a small proportion of the vehicles taking part in them, but it is certain that if it were not for the draconian rules which prevented competitors from carrying out slight repairs, that are always provided for in normal service, a much larger number of vehicles would have qualified for the final test. As a matter of fact only three wagons were actually put out of the trials, mainly through damages in collision, and all the others continued running unofficially. The trials have created a good deal of irritation among the French makers, who are of the opinion that they have not been given a fair chance, and that tests of this kind are bound to be misleading. If the trials are to be resumed in the future they will have to be carried out upon entirely different lines.

## OBITUARY.

### PERRY FAIRFAX NURSEY.

MANY engineers will hear with regret of the death of Mr. Perry F. Nursey, who died on Thursday last at the age of seventy-six. Mr. Nursey had a chequered career, but he made many friends, and his loss will be more regretted than that of men of higher eminence in the world. A few years ago he underwent a severe operation for an internal disorder, and although he had so far completely recovered as to go about his work with the enthusiasm and good humour which were his characteristics, his strength was no doubt diminished, and he succumbed last week after a very brief illness.

Mr. Nursey was trained, we believe, as a civil engineer in Ordish's office, but from a comparatively early date he seems to have been drawn to the literary side of his profession, and he acted at one time as the editor of the *Mechanics' Magazine*, and subsequently of *Iron*, a venture in which he had, we believe, invested some money. He wrote on a great variety of subjects, and, besides the two papers mentioned, he contributed articles to the *Times*, and to several of the engineering journals. But he will be chiefly remembered by reason of his long connection with the Society of Engineers, with which, with the interruption of a few years, he was connected in one capacity or another from its beginning, a little more than fifty years ago. He was appointed secretary in 1872; in 1886 he took the presidential chair, and in 1894 he was elected honorary secretary and treasurer; but five years later again became secretary, an office which he filled at the time of his death. "To me," he said, speaking of his connection with the Society in a Jubilee retrospect, "it is a record of pleasant memories and associations—of memories of those with whom I have worked shoulder to shoulder, but who have passed away, and of associations with those who have taken their place, and with whom I am now working to promote the general interests of the Society, which work, to its executive, has ever been, and still is, a labour of love." Mr. Nursey had endeared himself to every member of the Society, whose faithful and devoted servant he was, and not one of them but will hear with genuine regret of his death.

### THOMAS ANDREWS.

THE death occurred on the 19th inst., at Wortley, near Sheffield, of Mr. Thomas Andrews, F.R.S., head of the firm of Thomas Andrews and Co., iron manufacturers, of Wortley. Mr. Andrews was born at Sheffield in 1847; he was the only son of Mr. Thomas Andrews, also a native of Sheffield. He was educated at Broombank School, and subsequently received private tuition. He was carefully trained in metallurgy, mining and engineering, by his father, and on the death of the latter he succeeded him as proprietor of the Wortley Ironworks and the Wortley Silkstone Colliery.

In June, 1888, Mr. Andrews was elected a Fellow of the Royal Society. He had previously been awarded the Telford medal and the Telford premium in 1884 by the Institution of Civil Engineers, and Telford premiums in 1885 and 1886.

During the four years prior to his election to the Royal Society he had, at considerable cost, conducted research at Wortley Ironworks on the "Effects of Temperature on the Strength of Railway Axles," and from time to time the results of his investigations were published. His object was to determine on a large scale the resistance of metals to sudden concussion at varying temperatures down to zero (0 deg.) Fah., and at the same time to ascertain, if possible, some of the causes leading to accidental fractures on our railways. In the course of low temperature observations on this large scale above 300 tons of snow were consumed for the freezing mixtures, &c., and over 400 railway axles were tested to destruction.

Electro-chemical effects on magnetising iron next occupied Mr. Andrews' attention, and in June, 1889, he read a paper on this subject before the Royal Society. In 1895 he was awarded the Bessemer premium by the Council of the Society of Engineers, London, for his papers on "The Effect of Strain on Railway Axles" and "The Minimum Flexion Resistance Point in Axles," and in 1902 he was awarded the gold medal of the same Society for a paper on "The Effects of Segregation on the Strength of Steel Rails."

He was widely known as an author on scientific subjects. It would not be possible with the space at our disposal even to give a list of the books and papers which he gave to the world at various times. Few men have expended more time and effort and research work in connection with metallurgical, physical, and engineering science than did Mr. Andrews.

### J. J. TINKER.

WE regret to have to announce the death of Mr. J. J. Tinker, who died at his home, Ashton-road, Hyde, on the 24th inst. He had been connected with the firm of Tinkers, Limited, Daisyfield Boiler Works, Hyde, Manchester, since its commencement, and for the last ten years had been managing director of the company.

## LAUNCHES AND TRIAL TRIPS.

WAIHORA; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Union Steamship Company, New Zealand; dimensions, 385ft. by 52ft. beam; to carry 7500 tons; engines, triple-expansion; constructed by the builders; trial trip, May 27th.

CARDIGAN, steel screw "trunk" steamer; built by Messrs. Ropner and Son; to the order of Messrs. Jenkins Brothers, Cardiff; dimensions, 370ft. by 51ft. by 26ft.; to carry 7100 tons; engines, triple-expansion, pressure 180 lb.; constructed by the North-Eastern Marine Company; launch, May 28th.

MALTE, steel twin-screw passenger steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Compagnie des Chargeurs Réunis, of Paris and Havre; dimensions, 500ft. by 55ft. 8in. by 36ft. 11in.; to carry 9000 tons; engines, triple-expansion, pressure 180 lb.; constructed by the Wallsend Slipway and Engineering Company, Limited; launch, May 30th.

MIRANDA, twin-screw steamer; built by Messrs. Mackay Brothers, Alloa, N.B.; to the order of Messrs. Fry, Miers and Co., London, for the Lloyd Brazileiro; dimensions, 235ft. by 36ft. by 12ft.; engines constructed by Messrs. Aitchison, Blair and Co., Clydebank; launch, May 31st.

PORTUGALETE, hopper steamer; built by Messrs. Wm. Simons; Renfrew; to carry 800 tons; engines, compound, pressure 120 lb., launch, May 31st.

ANINE, steel screw steamer; built by Wood, Skinner and Co., Limited; to the order of Mr. Martin Carl, Copenhagen; engines, triple-expansion, 17½in., 29in., 48in. by 33in. stroke; constructed by the North-Eastern Marine Company; trial trip, June 1st.

CHIKUGO MARU; built by David and William Henderson and Co., Limited, Partick; to the order of the Nippon Yusen Kaisha, Japan; dimensions, 310ft. by 40ft. by 26ft. 6in.; engines, triple-expansion, 25in., 41in., 68in. by 48in. stroke, pressure 180 lb.; constructed by the builders; trial trip, June 1st.

YARRA; built by Furness, Withy and Co., Limited; to the order of Huddart, Parker and Co. Proprietary, Limited, Melbourne, Australia; dimensions, 300ft. in length; engines constructed by Messrs. Richardsons, Westgarth, Hartlepool; trial trip, June 1st.

BETTY, steel screw tug; built by Messrs. James Pollock, Son and Co., London; dimensions, 82ft. long, 22ft. 9in. breadth; engines, triple-expansion, pressure 180 lb.; constructed by the builders; the tug has been designed for coping with the heavy and increased barge traffic between Tilbury Docks and London; trial trip, June 3rd.

DESPINA MICHALINOS, steel screw steamer; built by Messrs. Wm. Gray and Co., Limited; to the order of Messrs. Michalinos and Co., London and Piræus; dimensions, 342ft. 6in. by 47ft. 6in. by 22ft. 6in.; engines, triple-expansion, 23½in., 38in., 64in. by 42in. stroke, pressure 180 lb.; constructed by the Central Marine Engine Works; trial trip, June 7th.

## RAILWAY SAFETY APPLIANCES IN AMERICA.

FROM the annual report of the Interstate Commerce Commission for the fiscal year ending June 30th, 1905, it appears that there were on that date 48,357 locomotives, of which 11,618 were passenger, 27,869 freight, and 7923 switching—and 1,842,871 cars—40,713 passenger, 1,731,409 freight, and 70,749 railway service.

Of those in the passenger service all but 82 locomotives and 163 of the cars had automatic couplings, and nearly all were equipped with continuous brakes. In the freight service practically all the locomotives have automatic couplings and continuous brakes, and of the 1,731,409 cars 1,715,854 had automatic couplings, and 1,515,354 had continuous brakes. The purpose of the legislation of 1893, 1896, and 1903 as to the equipment of automatic couplings and continuous brakes may, therefore, be considered as achieved. During the year ending June 30th, 1893, the year of the original Safety Appliance Act, there were 433 men killed and 11,277 injured in coupling accidents, whilst in the year ending June 30th, 1906, there were only 311 killed and 3503 injured, and this favourable reduction is the more remarkable when the great increase in the volume of traffic and number of men employed is considered. Lest these figures should, however, be used as an argument in favour of equipping British rolling stock with automatic couplings, it should be noted that it is reported in the annual return of the Board of Trade for the year ending December 31st, 1905, that there were 12 employés killed on our railways, and 523 injured in coupling and uncoupling vehicles. Owing to the classification of the number of men employed being different in the two countries, a definite comparison cannot be made. It may, however, be remarked that in America there are 265,175 "trainmen," which includes engine-drivers, firemen, conductors, and "other trainmen." Of the goods guards, brakesmen, engine-drivers, firemen, shunters, porters, and passenger guards there were on British railways in 1904 a total of 135,840. Taking these figures as being fairly comparable, we find:—

| | America. | Great Britain. |
|---|---|---|
| Trainmen employed ... ... | 265,175 | 135,840 |
| In coupling accidents: | | |
| Killed ... ... ... ... ... | 311 | 12 |
| Injured ... ... ... ... ... | 3,503 | 523 |
| One killed in every ... ... ... | 852 | 11,320 |
| One injured in every ... ... | 75 | 260 |

As was pointed out in an article on "Automatic Couplings and Either-side Brakes" in THE ENGINEER for April 27th, 1906, the figures as to the number of servants injured on American roads cannot be relied upon, but the return as to fatal accidents is sufficient to prove that automatic couplings, whilst reducing the number of casualties, has not brought the record in America to the same level as on British railways where they are, practically, not employed.

The success achieved by the Safety Appliance law has encouraged the Interstate Commerce Commission to go further. A compulsory adoption of the block system was proposed in 1903, but it has not yet been considered in the legislative chambers. In the meantime, on a joint resolution of Congress, approved June 30th, 1906, an investigation has been held into this subject, and the report thereon has recently been issued. Reference was made to this in our monthly notes for March.—THE ENGINEER, April 5th last. Before commenting on that it should be noted that a Bill for regulating the hours of labour of railway servants was approved on March 4th last, and directed to come into force twelve months later. By this Act it is provided that no servant shall be required or permitted to remain on duty for a longer period than sixteen consecutive hours; that after a period of sixteen continuous hours on duty he must have at least ten consecutive hours off duty, and any servant who has been on duty for sixteen hours in the aggregate in any twenty-four-hour period must have at least eight hours' consecutive rest. For train-dispatchers, operators and others who "by the use of the telegraph or telephone dispatches, reports, transmits, receives or delivers orders pertaining to or affecting train movements," a nine-hour day is ordered where offices and signal-boxes are open continuously, and thirteen hours where open during the daytime only. The need for such a law has long been apparent. The excessive hours worked by trainmen have been a scandal for which the men have been as much to blame as the companies, as they have never complained.

The use of the block system is very much needed, and especially on single lines, of which there are 197,093 miles out of the 216,973 total length of railway. It may here be remarked as a matter of interesting information that there are in the United States 197,093 miles of single track railway, 17,056 double, 1609 treble, and 1215 quadruple. In addition to which there are 69,941 miles of sidings. It appears from some figures compiled by the *Railway Age* as to the extent the block system is in use in America that on December 31st last only 38,546 miles of single track, or 19 per cent., are protected by the block system or its equivalent—staff, tablet, or automatic signals. The remaining 81 per cent. are controlled by "train orders" issued by the train-dispatcher, who advises, by telegraph, the operator—who is generally station agent, booking clerk, telegraph clerk, towerman, &c. combined—as to what is to be done.

Mistakes sometimes occur in transmission or in writing down the message. This message has to be written out, read over, and copies given to the enginemen and conductor. It may, however, so happen that before the train arrives the instructions may be modified by a subsequent message or messages, and then in the end the wrong instructions are given. These instructions may be that an east bound train is to proceed from A to B and wait at the latter place for a certain west-bound train, which is running in two sections. The latter information may be overlooked. Or it may be an intimation that a certain west-bound train has been instructed to proceed to A instead of crossing at B. But really it is unnecessary to specify the numerous ways in which "train orders" may fail by being misread, misunderstood, forgotten, overlooked, &c., and cause disasters on single tracks. Here is a case from the last quarterly bulletin of the Interstate Commerce Commission:—A collision occurred between a west-bound passenger train and an east-bound freight, which resulted in the death of 42 passengers and one trainman and injuries to 150 passengers and five trainmen. It happened at three o'clock in the morning during a blinding snowstorm. The passenger train was the second portion of an ordinary train, the first portion of which carried green flags at the foot of the smoke stack to indicate to trains running in the opposite direction that they must keep out of the way of the second section. A freight train bound east stood on a siding when the first portion went by and started out when the first portion had passed, as the head light fixed near the flags was out, and the men in charge of the freight had, therefore, no visual indication as to the second portion. To provide against such a failure of the head lights the engineman is required to give one long and two short blasts on his whistle when passing a standing train. This was done, but the men in charge of the freight train thought it was the two long and two short whistles for a level crossing and did not give the acknowledging whistle. That being so, the engineman of the passenger train should have stopped and given the proper notice verbally, but this he omitted to do.

Were it not for the serious results that arose out of the above circumstances, one would feel tempted to smile at such primitive methods of working railways as relying on a couple of green flags carried on the front of an engine—which cannot be seen at night if the head-light be out, and even might not be in position at all—to guard against trains meeting on a single line. This occurred, too, on a line—the Baltimore and Ohio—which is one of the principal lines in America, and which has a capital of 428 million dollars. It must be admitted that there are difficulties in the way of a compulsory adoption of a block system, and there are good and sufficient reasons why it has been delayed. It is, however, bound to come soon, and then the poorer lines where primitive methods are safe must suffer for the indifference and delay of the larger companies like the Baltimore and Ohio. It was so here in 1889, when the popular excitement, over the Armagh disaster on the Great Northern Railway of Ireland gave the Board of Trade the opportunity they were longing for to secure compulsory interlocking of points and signals, the adoption of the block system, and the use of continuous brakes on passenger trains. At that time 93·5 per cent. of the points and signals in England, 82 percent. in Scotland, and 59 per cent. in Ireland were interlocked, but the Great Northern of Ireland—then as now one of the richest in the United Kingdom—had only 26 per cent. interlocked. The block system was in use on 97 per cent. of the lines in England, 99 per cent. in Scotland, and 31 per cent. in Ireland, but the Great Northern record was 14 per cent.

As a preliminary, then, to legislative action, and with a view to educating the members of Congress, and also possibly further arousing public opinion, a resolution was passed, as has already been said, authorising the Interstate Commerce Commission to investigate the question. Two experts were employed to compile a description of the various systems and apparatus, and this forms a very useful appendix to the report of the Interstate Commerce Commission which was presented to Congress in February last, and which closes with a recommendation that the use of the block system should be made compulsory on the passenger lines of the country in general, and that the work should be completed within three or four years.

It must not, however, be imagined that the block system is the sole remedy for railway accidents in America, or that they will be very considerably reduced. The last quarterly bulletin of the Interstate Commerce Commission is for the three months ending last December. In this thirty of the principal collisions of the quarter are named and the causes assigned given. From this we find that fifteen of these arose through errors in train orders, which signifies an absence of the block system. But five occurred through irregular block working, and three were due to enginemen passing signals at danger.

Towards the end of their report the Commission not only support the proposals of 1903 as to a compulsory block system, but also those proposals for giving supervisory powers to a proper authority. The report says: "Supervision is necessary, not only to ensure that the specific requirements of the law are complied with, but also because of differences in methods of construction and operation and in the standards of perfection and safety on different roads where the block signal system is already in use." This is, we assume, on the same lines as the Safety Appliances Act, under which inspectors employed by the Commission go round seeing that the law is complied with. This is certainly very foreign to our views, as the Commission are thereby accepting a responsibility which is undesirable. However, as no recommendation was made on this point in the conclusion to the report, the matter need not be argued further by us.

Considerable correspondence has appeared in the technical press of America of late on the subject of automatically pulling up a train in case a stop signal be passed at danger. On first presentation this seems a good idea, but a more or less calm consideration of the subject will soon reveal objections which, if overcome, will still leave difficulties as to the type of stop, its position, what it achieves, and how, &c. However, public opinion, backed by sadly too many cases of drivers passing signals at danger, has given the Interstate Commerce Commission a desire to see something done in this direction. The report, therefore, contains a further recommendation that investigation by official tests of automatic appliances for the control of railway trains be authorised, with an appropriation of sufficient amount to conduct such tests in a proper manner. The latter portion had already been anticipated, as Congress voted 50,000 dols. towards this end.

The most interesting and probably most important of the three recommendations has yet to be noticed. This reads: "That with or without the passage of a law requiring the use of block signals, there should be a law authorising an official investigation of train accidents and providing for the employment of competent persons to perform the duties imposed by such an enactment." There can be no possible objection to such a proposal, but it is undertaking a huge task. Let it be remembered that in the year ending June 30th, 1906, there were reported to the Interstate Commerce Commission no fewer than 7194 collisions and 6261 derailments, or 37 per diem. It is not difficult to imagine the feelings of the Board of Trade, were it called upon to deal with even a small portion of that number.

## ROYAL MAIL STEAMSHIP AVON.

ON Saturday, June 22nd, the Avon, which is the fourth of the twin screw steamers which the Royal Mail Steam Packet Company has within the last two years placed on its South American mail service, left Southampton for a short cruise, carrying on board a large party of visitors whom the company had invited to inspect its new acquisition, before she takes up her position in the South American service on June 28th.

The Avon was launched by Messrs. Harland and Wolff at Belfast on March 2nd last. She is a schooner-rigged vessel with two masts Her length is 534ft. 9in., her breadth 62ft. 4in., and she has a gross register of more than 11,000 tons. She has been designed to carry a large quantity of cargo, but elaborate passenger accommodation has also been provided, the passenger capacity being 289 first class, 64 second class, and a large number of third-class passengers. Up to the present the maximum speed attained with this boat has been 14 knots, but an official speed trial has not yet been made. As a fact, we understand that the company anticipates obtaining a maximum speed of considerably over 16 knots.

Excellent facilities have been provided for loading the cargo, there being five hatchways of large dimensions, and ten hydraulic cranes, each having a lifting capacity of 50 cwt. The main engines are of Messrs. Harland and Wolff's latest balanced quadruple type, the diameters of the cylinders being 27in., 38½in., 55in., and 79½in., and the stroke 4ft. 6in. The boilers, which were also supplied by Messrs. Harland and Wolff, are of the ordinary Scotch type, and are seven in number, three of them being double-ended and four single-ended. There are in all thirty furnaces. The steam pressure is 200 lb. per square inch. Special movable fire bars are in use for breaking the clinker, and each bar is moved separately by a detachable spanner. The stokehold contains the usual ash ejector, by means of which the ashes are conveyed to the sea. Induced draught is employed for the furnaces, and there are in all eighteen fans driven by electric motors supplied by Messrs. Lawrence Scott. The ship is electrically lighted throughout, and the auxiliary machinery used in connection with cooking, heating, ventilating, &c., is driven by electric motors. The electrical generating plant consists of four Allen's steam-driven compound dynamos, each having a capacity of 48 kilowatts and a full load pressure of 110 volts, running at a speed of 438 revolutions per minute. The engines are of the triple-expansion type. The switchboard is divided into two parts, one part for lighting and the other for power, and also carries the main machine switches and instruments.

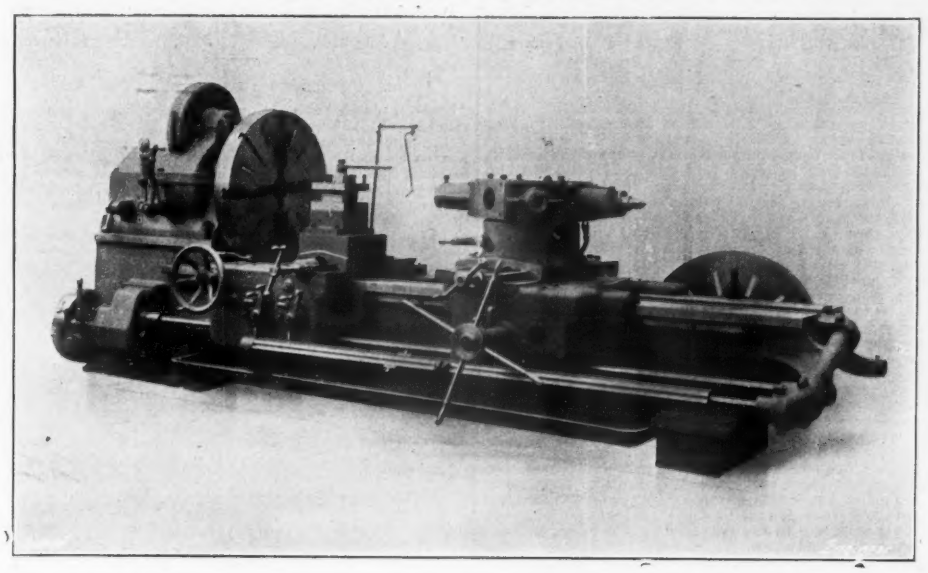
## FIVE MONTHS' SCOTTISH SHIPBUILDING.

THE heavy tonnage, the large number of vessels, and the wide variety of work are all features of the output of shipping during May from the yards of the Clyde and the East Coast of Scotland. Altogether sixty-three vessels of 65,290 tons were floated, forty of 62,240 tons on the Clyde, four of 1280 tons on the Forth, eight of 720 tons at Dundee and Montrose, and eleven of 990 tons at Aberdeen and Moray Firth ports. The month's Clyde tonnage is the second largest this year, and easily the largest on record for the month of May. It includes the 12,000-ton turbine steamer Heliopolis at Fairfield, the King's yacht at Pointhouse, another turbine vessel at Dumbarton, a dozen screw steamers of various sizes, one paddle steamer, ten dredging craft of different types, a twin screw yacht, and seven steam drifters—a comparatively new feature in Clyde shipbuilding. The Clyde total for the five months is 242,390 tons, 30,670 tons more than that of last year, the previous highest tonnage. On the East Coast the output consists almost wholly of steam drifters, twenty of these and one screw tug having been launched during the month, nearly all for Scottish herring fishing ports. If the various labour questions now under the consideration of employers and men do not dislocate work during the summer, the yards should be fairly busy all through the year. During May there were reported contracts amounting to about 30,000 tons, the most important item being an order secured by William Beardmore and Co., Dalmuir, for a twin-screw steamer of 11,500 tons for the Pacific Steam Navigation Company. The total, however, is lower than the average bookings for a month, but there is a fair amount of tonnage on hand in most of the yards, and only industrial peace is required to ensure a summer and autumn of average work.

MANCHESTER ASSOCIATION OF ENGINEERS.—On Saturday last the members of this society, accompanied by their wives and lady friends, to the number of about 350, were entertained by Mr. Joseph Adamson, the President, and Mrs. Adamson at a garden party at the Oaklands, Godley, Hyde. A very pleasant afternoon was spent in the extensive and well-laid-out gardens, notwithstanding that the weather was unsettled. Mr. Hunter, in a few words, thanked the President and Mrs. Adamson for the enjoyable entertainment they had provided. Mr. Webb also addressed the members, and Mr. Adamson replied in his characteristic manner. The Great Central Railway Company provided pecial railway accommodation for Mr. Adamson's guests.

# SURFACING AND BORING LATHE

TANGYES LIMITED, BIRMINGHAM, ENGINEERS



## SURFACING AND BORING LATHE.

THE accompanying engraving shows a new surfacing and boring lathe by Messrs. Tangyes, Limited, Birmingham. It has been designed for surfacing and boring locomotive cylinder covers, pistons, axle-boxes, &c., but can also be used for turning and boring a large variety of chucking work. The headstock is of the all-gear type, driven direct by gearing from a motor carried on the base at the back of the lathe. There are eight changes of speed provided in the headstock, the changes being made and the lathe stopped and started by means of levers and a friction clutch on the driving shaft. The motor is of the variable speed type, and the intermittent speeds are obtained by means of a shunt rheostat, so that practically any speed from 5 up to 340 revolutions per minute may be obtained on the spindle. The latter is of steel, and runs in hard gun-metal bearings. It has a 3½in. diameter hole right through, and a screwed nose to receive a chuck or face-plate. The bed is of deep and wide section, and carries two saddles. The left-hand saddle is fitted with a square turret for carrying four tools, and has self-acting, sliding and surfacing motions from a shaft carried in front of the bed. Each motion is independent of the other, being controlled by means of drop worms and hand levers. The right-hand saddle carries a hexagon turret on a slide, which is arranged for taper boring from a bar at the back. The saddle has a sliding motion from the feed shaft at the front, and an automatic stop motion by means of a dropping worm and lever which is actuated from a stop carried on a hexagon bar in front of the bed. The bar carries six stops, one for each face of the turret, and revolves automatically as the turret is turned, and thus putting into action the stop relating to the tool in operation. The hexagon turret has a powerful locking motion to the slide, and revolves on ball bearings. It is provided with six hardened steel bushes, one for each face, and each face is fixed by means of a vertical hardened steel pin, fitted in a hardened steel bush in the slide. The slide is provided with a taper peg for keeping turret in the centre of the lathe when required for boring. Each saddle is arranged with quick hand traverse. The feed shaft has six changes of speed, all of these being obtained while the lathe is running by a movement of two levers. Suds pump and tray with the necessary piping are arranged for flooding the work which is being machined. The principal dimensions of the lathe are—

| | |
|---|---|
| Height of centres .. .. .. .. .. .. .. .. | 18in. |
| Diameter of chuck .. .. .. .. .. .. .. .. | 36in. |
| Length of bed .. .. .. .. .. .. .. .. | 14½ft. |
| Distance between face of hexagon turret and chuck | 7½ft. |
| Depth of bed .. .. .. .. .. .. .. .. | 14in |
| Width of bed .. .. .. .. .. .. .. .. | 26½in. |
| Spindle, front bearing .. .. .. .. .. | 6in dia. by 7½in. long |
| Spindle, back bearing .. .. .. .. .. | 4in. dia. by 6in. long |

The approximate finished weight of the lathe without motor is 7¼ tons.

## THE "JAMES FORREST" LECTURE, 1907.

### "UNSOLVED PROBLEMS IN THE DESIGN AND PROPULSION OF SHIPS."*

By FRANCIS ELGAR, LL.D., F.R.S., M. Inst. C.E.

(*Concluded from page 637.*)

AN attempt has recently been made to provide an experimental tank at the National Physical Laboratory, to be worked by members of the staff there, at which ship models might be tested for resistance, but up to now it has been without result. There is another way of dealing with the matter, however, and a better one for the ordinary purposes of the ship designer, which has been initiated by Mr. R. E. Froude, that promises to overcome the difficulty in a satisfactory manner. Mr. Froude read a paper at the Institution of Naval Architects, three years ago, upon "Some Results of Model Experiments," in which he gave results of a series of general experiments on systematic variations in form of hull, the variations consisting of six different sets of typical lines, varied in proportion by independent variations of length, beam, and draught. The resistance data given by these experiments are published in the paper in such a form that the resistance of a ship of any dimensions, whose lines are similar to the typical ones, which are also shown, can readily be taken out. The types dealt with have block coefficients, or ratios of displaced volume of water to product of length, breadth, and draught, varying from ·4865 in the finest to ·541 in the fullest. Now this series covers a very important class of mercantile steamers—that of fast Channel boats—and the designer of such a boat could have nothing better for his speed calculations than the data in this paper. He has only to refer to Mr. Froude's tables and curves in order to determine at once the proportions and form that will best suit the circumstances, and to construct the lines of his boat.

There could be no better solution of the speed problem for practical purposes than a continuation of the work that Mr. Froude has thus begun so well. This would be the greatest boon to ship designers. The method has been employed with most successful results in the practical design of ships of the class I have mentioned. I know of three vessels which have been made to approximate closely to Mr. Froude's forms, and whose estimates of speed have been based upon his data. The turbine steamer Dieppe, which runs between Newhaven and Dieppe, is intermediate in form between Mr. Froude's No. 5 and No. 6 types. Her block coefficient of fineness is ·538, with a water-line length of 280ft., and a speed of over 21 knots. She had to be increased in beam and made fuller in form than the previous vessels of the line, in order to carry additional weight, upon dimensions and draught of water that were strictly limited, without reduction of speed, and the best data available for determining the form that would fulfil these exacting conditions was Mr. Froude's. The result was a conspicuous success, as the Dieppe has proved to be the fastest boat of the line. The same procedure has been equally successful and satisfactory in the new turbine steamer Viper, of the Burns Line between Ardrossan and Belfast, another 21-knot boat whose lines are those of Mr. Froude's No. 4 type, and also in the twin-screw steamer Hazel, fitted with ordinary reciprocating engines, just built for the Laird Line between the Clyde and North of Ireland, whose length is 260ft. and service speed 18 knots, and whose lines are based upon those of Mr. Froude's No. 4 type.

These results of the practical employment of Mr. Froude's methods and data are sufficient proof, if proof were needed, of their value; and one may say that, for the ships represented by his types, the ship designer is thus practically independent of further tank experiments. The power and speed data necessary are all recorded in Mr. Froude's curves and tables, ready for immediate application. If similar data could be obtained for other forms of ships, say, for the fast-liner type, with block coefficients varying from about ·6 to ·7, the designer of that class of vessels would, indeed, have cause to be grateful. The best practical solution of this long-vexed problem of speed appears to be an extension of Mr. Froude's system to vessels of the fast-liner type, and others with which the ship designer ordinarily has to deal, leaving those of abnormal proportions or form, and freaks, and also the work of general research, to a public experimental tank—if ever we find enterprise enough among those interested to get one set up in this country.

Thence he went to screw propellers and steam turbines. The resistance of a ship may be estimated to a close degree of accuracy in the manner mentioned, but the determination of the engine power required to overcome that resistance involves the consideration of screw-propeller efficiency. The problem of the most efficient design of propeller for a given size and form of ship and rate of turning of shaft is as yet far from practical solution.

Several attempts have been made to construct a theory for the action of the screw propeller. These involve, however, certain ideal assumptions for simplifying the problem, which would otherwise be too complex for theoretical treatment. It does not seem likely that any purely mathematical theory will be found sufficiently reliable to enable the best screw dimensions to be determined for a given ship, and consequently we are bound to fall back upon the experimental method. It is this method which was developed by the late Mr. W. Froude, and has been continued by Mr. R. E. Froude in the Haslar tank. Model experiments have been carried out on a large number of propellers of varying pitch, diameter, and developed area; but these model screws have been very small, the size and speed at which they could be worked being limited by the stresses which the experimental mechanism is capable of bearing. This difficulty has been greatest in the case of screws for turbine vessels, because the shafts necessarily run at much higher revolutions in them than with reciprocating engines; increased speed of turning being necessary to secure good turbine efficiency.

In applying the model screw results to full-sized ships recourse must be had to a law of comparison, similar to that obtaining between the model of the hull and the full-sized ship, and in this direction it is of great importance that further investigation should be made. Further advance might probably be effected by carrying out experiments in a tank on a larger scale than those already made, and with stronger appliances than those now used for the purpose in the Admiralty tank. A still more effective means, which I hear is under consideration by Mr. Froude, would be to build an experimental launch for the purpose, to be run in open water and propelled by machinery of considerable power. The propelling machinery could be so arranged that the thrust of the screws and the torque on the shaft could be automatically recorded, as in the case of tank experiments. With such an arrangement screws up to 3ft. in diameter could be experimented with—a great advance on anything that could be hoped for in the tank—and the important problem of propeller efficiency might thus be brought within reach of practical solution.

We now come to the greatest problem of all with regard to the propulsion of ships, and that is the form which propelling machinery is likely to take in the immediate future. Already an important change is in progress from the ordinary reciprocating marine engine to the steam turbine; and the question is not only how far that change will extend, but also whether the whole of the cumbrous apparatus required for producing steam may not before very long be swept out of mercantile steamers, and the power be obtained from some form of internal-combustion engine. It would be rash to attempt to prophesy what will happen, but a short reference to what appears to be the present position with regard to these fundamental questions might be expected.

The progress of the steam turbine is remarkable. It has often been described by Mr. C. A. Parsons and others, and is pretty well known. The reasons why its progress has not been greater, and why it is not already more generally employed in ships of all classes, are not so well known, and it might be useful to consider them. The Parsons steam turbine has practically superseded the reciprocating engine in the battleships, cruisers, and smaller very fast craft of our Navy, and it has had equal success in the very important class of Channel steamers and other boats of similar type. Turbine steamers now employed on cross-Channel services are running at speeds that could not be reached with the best reciprocating engines. They are strictly limited in many cases to a very shallow draught of water; they carry very little deadweight of coal and cargo; the weight of their machinery and boilers constitutes a large proportion of their gross weight, and the percentage of the latter that is saved by the use of fast-running turbines is sufficient to give a substantial advantage in speed. The coal consumption compares favourably with that of the best reciprocating engines of equal power that could be fitted in that type of ship, and still better, of course, with the paddle engines or screw-propeller engines of old type which were in the boats they superseded.

When these facts are stated, as they often have been, surprise is expressed by many that such apparent advantages are not secured more extensively for other classes of vessels. Very few ocean steamers have been fitted with turbine machinery or are being so fitted; and although this may not cause surprise in the case of cargo boats and other vessels of low or even moderate speeds, it appears strange that liners of high speeds are still being fitted with reciprocating engines, and that the bold lead given by the Cunard Company with their two fastest new boats and the Carmania should not be generally followed.

The chief reason for hesitation to put turbine machinery into ocean liners is the doubt which exists as to coal consumption. The amounts at stake are so large in these costly vessels when experiments with novel propelling machinery are tried that everybody prefers to see some one else make them. The Cunard Company are making the crucial experiment upon the largest scale that is now possible, and every one interested in progress must wish those responsible for it all the success they hope for and deserve. But the result is to some extent uncertain, and the immediate future of the turbine in fast liners depends greatly upon the issue.

In warships the consumption of coal has been brought down to 1·7 lb. per equivalent indicated horse-power of reciprocating engines per hour, and to about the same figure in mercantile boats of cross-Channel type. That is as good as can be obtained with reciprocating engines in the same classes of vessels, as weight has to be kept down as much as possible in these by shortening the stroke, and using high mean pressures of steam in the cylinders, in order to get all the power that is practicable out of a moderate size and weight of machinery. It pays better in these cases to stop somewhat short of the maximum efficiency attainable than to carry the additional weight that the increase would involve. In ocean liners the conditions are different, and economy of consumption is the chief point aimed at. Their consumption with quadruple-expansion engines and a boiler pressure of 210 lb. to 220 lb. has been brought down to 1·3 lb. of coal per indicated horse-power per hour. The substitution of turbines for reciprocating engines in ocean vessels depends chiefly upon whether the consumption with turbines can be brought down to this figure, and there is no satisfactory evidence that this is now practicable. It is probable that the marine turbine will ultimately be so improved as to beat the best reciprocating engines in economy of consumption in ocean liners, but no proof is forthcoming that it can yet do it.

In ocean liners the turbine has to compete with the reciprocating engine at its best, and the development of high efficiency with the turbine is counteracted by loss of propeller efficiency as speed of turning is increased. The problem is to secure a combination of turbine and propeller such as will give an efficient speed of turbine without reducing unduly the diameter of propeller, and experience with regard to this is much needed. The smaller propellers of turbine engines doubtless gain in efficiency on service by being immersed more deeply, and being thus less affected by the rising and falling of the sea at the stern. This is especially the case with some of the cross-Channel boats, in which the propellers have to be so large relatively to the shallow draught of vessel with reciprocating engines, even when these are run at the greatest possible number of revolutions per minute, that they are sensibly affected by the least disturbance of water level. The difference in propeller efficiency soon becomes very marked as the weather gets bad. In the Newhaven and Dieppe service, for instance, it is found that whereas the turbine boat Brighton only gains an average of three minutes upon the time of the reciprocating-engine boat Arundel in fine weather, she gains fifteen minutes in anything like bad weather. The difference in favour of the turbine on account of extra immersion of propeller is not likely to be so great as that in ocean liners, because in them the immersion of propeller is not relatively so unfavourable with reciprocating engines, but it would doubtless be of appreciable value. There appears to be some other cause, however, which operates unfavourably in bad weather at sea, especially when running against a strong head wind, to turbine vessels with comparatively small propellers. In such circumstances they fall off in speed more than reciprocating-engine boats with their large propellers would do; and altogether, notwithstanding the greater depth of immersion, the efficiency of the propellers appears to diminish more rapidly as they are reduced in diameter when driving the vessel against a head wind and sea.

It might be interesting to give some particulars of two fast turbine steamers that are being built by the Fairfield Company for the Egyptian Mail Steamship Company to run between Marseilles and Alexandria. These vessels will go upon their station at the beginning of next winter season. They are 525ft. in length and their speed on service is to be 18½ knots. The turbines are to run at about 340 revolutions per minute, a rate which necessitates as small a diameter of propeller as prudence would allow. Everything that appears possible has been done to favour the efficiency of the turbine and reduce the weight of machinery. The boiler power is increased 6 per cent. above what would be allowed for reciprocating machinery of equal power, but the gross weight of engines, boilers and auxiliaries work out about 400 tons lighter for the turbines. The space occupied by the boilers and machinery is practically the same. A greater consumption of coal and a corresponding increase of bunker capacity has been allowed for, and it remains to be seen how the consumption will work out.

I am enabled by the kindness of the general manager of the London, Brighton, and South Coast Railway, to give some further particulars of the speed and consumption of their two boats, the Arundel and Brighton, the former fitted with ordinary reciprocating engines and the other with turbines. These vessels are approximately similar in dimensions, displacement, and form. The figures given are the averages of more than a year's running, during which a total distance of about 20,000 miles was covered in each case. The average speed of the Arundel was 19·29 knots, with an average consumption of coal per trip of 16·16 tons. The corresponding figures for the Brighton are an average speed of 19·59 knots, with 17·18 tons of coal. If the figures for consumption be corrected so as to give the comparison at equal speeds, it will be seen that there is nothing to choose between the two boats in economy of fuel.

The difficulties of stopping and manœuvring vessels propelled by

* Abstract. The Institution of Civil Engineers, 18th June, 9 p.m.

turbines have been overcome by adding turbines of considerable power for going astern. In the Dieppe the astern turbines are two-thirds of the full power ahead, and she was stopped dead upon the official trials when going at a speed of 12 knots in 1¼ times her length, the time taken in bringing her to a standstill being 31 seconds.

Speaking of internal combustion engines, he referred to Mr. Milton's paper read last January, and thence to comfort on shipboard, and the means of controlling rolling and pitching and vibration, concluding with a reference to the freedom with which the travelling public paid large sums for high speeds.

## NOTES FROM SOUTH AFRICA.

*(By our South African Representative.)*

JOHANNESBURG, June 3rd, 1907.

THE strike of the miners shows distinct sign of coming to an inglorious end within the next few days. From its commencement, about three weeks since, there has appeared to be very slight hope of the men being successful. They have no real grievances. They receive very high pay, the average pay for all white men employed underground on the Rand being about 28s. per shift of eight hours. The conditions under which the men work are certainly equal to those elsewhere; it is only on exceptional work that there is any greater risk than in other parts of the world. The man working machines in stopes has no greater chance of developing "miners' phthisis" than on a mine elsewhere, provided he uses the dust allaying devices which are provided under the law. The leaders of the strikers have made very determined efforts to win. They declared a general strike of all underground men. This resulted in a great access of strikers, the total number of men out at one time reaching some 5000. A great proportion of these were induced to leave work, however, owing to their fear of personal violence. Had the mine managers been able to ensure their safety fully 50 per cent. would have remained at work. It is remarkable to what a small extent the mines were handicapped by the loss of so many employés. In some instances practically all the underground men were on strike, yet the staffs, with the assistance of a few surface men and unskilled recruits, managed in almost every case to keep the entire battery supplied with ore. Only in one or two instances have any stamps been "hung up" owing to the strike, and the output for the month will not be appreciably affected by it.

A strong effort was made last week to induce the hauling-engine drivers to come out; a ballot of members of the Drivers' Association was held and a majority of nearly 90 per cent. of the members declared against striking. On the 1st inst. a deputation of miners waited upon the Government and laid their case before the Ministers. General Botha was decidedly unsympathetic, and pointed out that a time when two Government Commissions were sitting to inquire into the working of the industry and to report upon what changes were necessary in the mining regulations, was not the proper time to force matters by means of a strike. He informed the deputation that if the Commissions reported that it was more injurious to the men's health to work three machines instead of two, the Government would introduce legislation to prevent the larger number being operated. Any other recommendations of the Commissions would also be acted upon at once by the Government. Numbers of the strikers have returned to work, and it is highly probable that a week or ten days will see the incident closed. There has been one decidedly useful end served by the strike, though it was unforeseen by the strikers. A large number of Boers have taken employment in the mines and show every sign of being able to do the work as satisfactorily as the British miners. In the near future a very large percentage of the miners employed will be of South African birth and the advantage to the country will be incalculable, as probably £50,000 to £100,000 per month, which is now sent out of the country by the miners to their families in England, will remain in the Transvaal.

The first of the two Belliss-Morcom generating sets, installed by the municipality to run the tramcars temporarily, has now been set to work. The second one will be started in two or three days' time. These two sets are each of 500 kilowatts capacity, and have been supplied and erected in record time. One engine was in the country, but the second engine and both generators had to be imported, yet the first set was delivering current five weeks after the order was placed, and the second will be under load within the six weeks. Messrs. Belliss and Morcom's local agents guaranteed to have the two sets at work, including three Babcock and Wilcox boilers, and a new smoke stack flue, &c., within eight weeks of the placing of the order.

## LETTERS TO THE EDITOR.

*We do not hold ourselves responsible for the opinions of our correspondents.)*

### COMPOUNDING AND SUPERHEATING.

SIR,—Pressure of other matters has prevented me replying earlier to your contributor's letter on the above subject, published in your issue of May 10th, page 482.

In so far as comparisons are concerned, the calculations given by "The Writer of the Article" are so largely suppositious that no locomotive engineer would accept them as being of themselves sufficiently conclusive to warrant him in adopting the new Italian State Railways compound system.

If that system, as your contributor incautiously—and, as I think, inaccurately—asserts, is 20 per cent. better than the Schmidt superheating system, may I courteously ask him why the Italian State Railways are now building twenty-four locomotives which will be fitted with Mr. Schmidt's apparatus?

I need not follow your contributor in his long and desultory dissertation on matters with which I have long been familiar. It will suffice if I point out that all the tests carried out with Schmidt superheater engines are based on coal of equal quality, and that the economy varies, as it does in every type of engines, according to conditions and circumstances.

As regards the statement that the 18 to 20 per cent. economy of the first De Glehn Nord compound locomotive, No. 701, has not been realised by the larger engines, I may point out that this saving was obtained in comparison with a precisely similar simple engine, with the two exceptions that the compound had independent driving wheels and an extra pair of cylinders. On the other hand, the Nord has never had any big single-expansion engines with which to compare the working of their later compounds. For the work that these last-named engines do, two locomotives of the original Nord compound type would be required.

Elsewhere on the Continent it has now been found that one superheater simple locomotive will generally do the work of two saturated steam compounds, all three engines being of approximately the same size.

The difficulty has always been to say how much is due to compounding and how much to other things. This is not the case with superheating, however. With superheating the source of economy is both direct and obvious. It is simply a question as to whether the saving in fuel and water is counterbalanced by the cost of upkeep of the superheater. On this point reliable and authoritative evidence shows that superheater locomotives are not in any respect more expensive to maintain than are saturated steam locomotives of like weight.

London, June 17th. F. W. BREWER.

### OVERTIME FOR APPRENTICES.

SIR,—With reference to "P. L. H.'s" letter in this week's number on apprentices, I should like to draw attention in your columns to a scheme which is being worked in this district, and which seems to me to get over a good many of the difficulties. It is a well-known fact that many boys pass the seventh standard before they are fourteen years old, especially if they are at all sharp. Now, under the present educational system, these boys must stay at school until they are fourteen years old, probably cleaning inkpots, giving out books, or doing some other work of this kind, and in the meantime forgetting a great deal of what they have previously learnt; and on leaving school, if one of them is going into the engineering trade, he is apprenticed to a shop and perhaps for the first twelve months is made a sort of errand boy for the stores or foreman until he finds out how to use his tools or, as "P. L. H." aptly puts it, "'picks up' enough knowledge to enable him to earn more for the firm by working at the vice than by running errands." Even then he has a very superficial knowledge of any of the uses of different materials, &c.

Now, under the scheme which is being worked here, this boy, if he proves smart enough to enable him to leave school at, say, twelve, which many do, he is drafted into a craft school to learn the rudiments of the trade he intends to follow. We will take the case of a boy who wishes to go into the engineering trade. He attends the craft school, working the same hours as he would at the day school, but instead of wasting his time, as he would be doing at the day school, a practical man is there to teach him how to use his tools, how to use the various machines, marking out, &c. Another technical teacher instructs him in the uses of various materials, their origin, strength, &c.; also how to make working sketches of various small articles and dimension the same. Thus, by the time this boy is fourteen years old and ready to go into the works, he is really better fitted than the other boy who has been in the works two years, as he has a knowledge which has not been "picked up" but which has been thoroughly taught.

On being drafted into the works, he has an understanding with his employer, also with the craft school, that he must still attend evening classes for, say, machine drawing, applied mechanics, &c., while he is serving his time. The scheme is quite young yet, but the employers in this district have taken very kindly to it and are doing all they can to help those managing the craft school, not only by asking them to supply them with boys, but by promising that they will not hinder them in any way from attending the evening classes while with them.

I must apologise for having taken up so much of your valuable space, but it seems that if some system of this kind were made general, it would be to the mutual advantage of both employer and apprentice. WORKS MANAGER.

Stroud, Glos., June 20th.

### COALITE.

SIR,—I have read your article on "Coalite," issued last Friday, with much interest, and admire its fair and judicial statement of the smokeless fuel problem. I venture to think, however, that a misconception enters into your last paragraph, where you argue that the manufacture of coalite involves no new principle, because dead-plate firing is essentially, in your opinion, the same treatment of bituminous coal. Of course, you state that you do not refer to details of machinery and plant and generally of manufacturing process, but only to the main physical or chemical action involved. But dead-plate firing, as practised for a century past, has an object which is totally different from that of coalite manufacture. Its object is the burning of smoke and, concurrently, the complete utilisation in combustion of all the combustible ingredients of the fuel. The object of coalite manufacture is to produce a useful fuel that yields no smoke. You very justly point out that in this manufacture the distillates are collected instead of being burnt, as in dead-plate firing and other cognate processes to which you refer. But even without this fundamentally important distinction, it appears to me that the entirely different objects aimed at, necessitating as they do entirely different apparatus and methods, and resulting in entirely different final products, constitute an essential difference in principle.

I may at the same time mention that neither coalite nor any material resembling coalite in useful properties is ever produced on the dead-plate of a boiler or other heating furnace.

Streatham, S.W., June 24th. ROBERT H. SMITH.

### EXPANSION OF RAILS.

SIR,—A line of the Chicago, Burlington and Quincey Railway runs in Wyoming over a high dry plain where in the summer the temperature is often 105 deg. Fah., falling at night by radiation through the clear dry air to 40 deg. Fah. Rails are, therefore, subjected to variations of temperature of 65 deg. Fah. at a few hours' interval.

On one occasion, in 1888, the section men discovered a rail slightly bent, and after drawing the spikes and loosening the plates it was still wedged too tightly to remove easily. It was therefore knocked with a sledge. It suddenly sprung free, struck a man and killed him, and the gap left was 8in. shorter than the rail removed.

It is evident that expansion had been prevented until the rail was released, and then instantly occurred through all the rails in several hundred yards. Had the rail not been removed a kink would suddenly, not gradually, have developed at some place of least resistance, and the kink might have occurred under a moving train. HARRINGTON EMERSON.

Schenectady, N.Y., June 8th.

### LAY OUT OF ENGINEERING WORKS.

SIR,—During this year consecutive articles have appeared in your paper on building of engineering works. Kindly permit me to point out that the principles laid down differ considerably from those adopted in many American and a few continental engineering works, where considerable quantities of comparatively light materials, half finished goods, and erected machinery have to be passed rapidly through the shops, such as in agricultural machine works, motor and light tool works. The wide spreading shed-roofed buildings are replaced by two and more storied ones, even there where the value of land or the smallness of the plot does not call for economy. With a good elevator, it is claimed, quantities can be more economically and speedily transported vertically than on a level. Thus smiths, turners, fitters are on the level ground, erectors on the first floor, and painters on top of building, the last department being kept better ventilated and heated than the rest. Pairs of elevators move from floor to floor only, thus a two-storied building will have at least two pairs of elevators. Even foundries are occasionally built storied, with cupola and casting floor on the top, sand mixing and cleaning below.

Charkow, June 22nd. C. BLAKEN.

### STEAMSHIP AUXILIARIES.

SIR,—In your Steamship Auxiliaries Supplement of the 21st inst. we notice an unfortunate confusion in the letterpress dealing with our manufactures. A sentence describing our air and circulating pumps of the crank type has been displaced, with the result that the impression is given that the pumps supplied by us for the s.s. Carmania were of the crank type. This is not so, as the various pumps which we fitted in this ship and also in the Mauretania and Lusitania were of the vertical duplex type.

We shall be obliged if you will have this correction made in your next issue.

Glasgow, June 24th. J. H. CARRUTHERS AND CO.

### CENTRIFUGAL TENSION IN DRIVING ROPES.

SIR,—"Student," whose letter on the above subject appeared in your issue of the 14th inst., has apparently not followed the rope maker quite far enough. If he refers to the paper read by Mr. Kenyon before the Institution of Engineers and Shipbuilders in Scotland, November, 1904, he will find the author destroys his own argument by the following statement:—"Time and again an endeavour has been made to so press a rope into an acute groove that it will retain its position during one slow revolution of the pulley, but immediately the ends are released it unbends and falls away." This shows that "stiction" is not worth consideration; hence centrifugal tension must be allowed for just as in high-speed belting.

Manchester, June 26th. PRACTICAL.

### FEEDING WATER INTO STEAM SPACE.

SIR,—I should be glad to know if any of your correspondents have had any experience of delivering boiler feed-water above water-line, say, delivering on to a channel plate with a fall of, say, 6in. in 15ft., the back end of the channel being perforated to allow the water to spray, and if they have found the same successful, also the probable amount of fuel saved. I should be interested to hear also if the feed can be effected in this way with an injector.

June 25th. ENGINEER.

## CATALOGUES.

THE HUGHES-JOHNSON STAMPINGS, Limited, Langley, Birmingham.—A pamphlet concerning drop forgings of many different kinds.

THE BRITISH INSULATED AND HELSBY CABLES, Limited, Prescot, Lancashire.—Leaflets P40 and P41 dealing with Prescot trolley wire and gun-metal cars respectively.

THE BRENTNALL RADIATOR AND CONDENSER COMPANY, Limited, 27, Pilgrim-street, Newcastle-on-Tyne.—A small pamphlet describing the "Brentnall" patented radiator for motor cars.

C. F. CARVER, Limited, Alfred-street Mills, Nottingham.—A price list of turned steel shafting, couplings, collars, pulleys, adjustable plummer blocks and hangers, bright steel washers, &c.

THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, P.A.—Record No. 61. This is a reprint from an article appearing in *Cassier's Magazine* of January last, entitled "The Steam Locomotive of the Future."

ROYCE, Limited, Trafford Park, Manchester.—A leaflet issued by this firm is devoted to an installation of electrically operated jib cranes and capstans supplied to the Hull and Barnsley Railway Company.

ROLLS-ROYCE, Limited, Conduit-street, London, W.—This catalogue contains a description of the Rolls-Royce six-cylinder motor car with sectional illustrations. There are also a number of Press extracts and testimonials.

A. AND P. STEVEN, Thanet House, 231-2, Strand, W.C.—A pamphlet on all kinds of lifts—electric, hydraulic (high and low-pressure), overhead tank, hydraulic pneumatic, steam, belt-driven and hand-power—for passenger or goods service.

THE SANDYCROFT FOUNDRY COMPANY, Limited, Chester.—A catalogue dealing with mining and electrical machinery, including breakers, stamps, cyanide plant, crushing machinery, engines for winding and pumping, &c., air compressors, boilers, mill gearing, wood work, generators, and motors for alternating and direct currents.

PILKINGTON BROS., Limited, St. Helens, Lancashire.—This catalogue of patent wired glass describes and illustrates the many uses and advantages which this useful material provides, especially in case of fire. It is produced in various ways—either rolled, cast, or clear polished. The book contains a large selection of illustrations showing the different applications to which wired glass can be put.

THE AMERICAN LOCOMOTIVE COMPANY, 11, Broadway, New York.—A pamphlet illustrating and describing different designs of eight-wheel American type passenger locomotives. This is the eighth of the series of pamphlets which is being issued by this company to cover its various standard types of locomotives. It contains twenty-five different designs of eight-wheel type engines, the principal dimensions of each design being given on the page opposite the illustration.

THE JUNIOR INSTITUTION OF ENGINEERS.—During the meeting of this Institution to the Clyde district, 1st to 5th July, the following works will be visited:—Messrs. Barr and Stroud's works, Caxton-street, near Anniesland; Messrs. Sir William Arrol and Co., Limited; Corporation sewage works; Messrs. Stewarts and Lloyd's tube works, Rutherglen; Farme Colliery and inspect Newcomen engine; North British Locomotive Company, Limited; elevating ferry at Stobcross; cattle lairage, Merklands Quay; Rothesay dock works, electric station, and coal hoists; Clyde Trust works, Renfrew Wharf; naval construction works of Messrs. Wm. Beardmore and Co., Limited; Corporation sewage works at Dalmuir; dock, and ore handling plant and pumping station at Queen's Dock; Fairfield Shipbuilding and Engineering Company; Messrs. Babcock and Wilcox's works; engineering laboratory, Edinburgh University; Forth Bridge; sewing machine works of Messrs. Singer; Messrs. John Brown and Co., Limited; Lanarkshire Steel Works; Messrs. Yarrow and Co., Limited. On Monday the members are to be received and entertained at luncheon by the Lord Provost and Magistrates of Glasgow. The summer dinner is to be held at the Windsor Hotel on Friday, 5th July,

THE SOCIETY OF ARTS.—The Council of the Society of Arts are prepared to award, under the Fothergill Trust, a gold medal, or a prize of £20, for the best portable apparatus or appliance for enabling men to undertake rescue work in mines or other places where the air is noxious. It is intended that the apparatus sent in shall be submitted to practical trials and tests. In the award of the medal regard will be had, first, to excellence of design and contrivance, and, secondly, to excellence of manufacture. Credit will be given to such parts of the apparatus as are the invention of the exhibitor, the object being to distinguish the apparatus which gives the best promise of being practically useful. Inventors intending to compete should send in a notice of their intention, together with a full description of their inventions, not later than 31st March, 1908, to the Secretary of the Society of Arts, John-street, Adelphi, London, W.C., and in cases in which the apparatus has been put into actual use the experience of such use should be given, and the special points of merit of the apparatus indicated. Competitors intending to patent their inventions should be careful to obtain protection, as the Council of the Society cannot undertake any responsibility as regards the secrecy of the whole, or of any part, of an invention submitted to them. The competition is not limited to British subjects.

## THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

*(From our own Correspondent.)*

### Foreign Demand for Iron.

MIDLAND and Staffordshire raw irons on Birmingham Exchange this—Thursday—afternoon were steady in price though immediate sales were few. The fall in Cleveland iron is believed to be due to speculative influences, but it is an undoubted fact that American iron has given way slightly. On the other hand, there are rumours already of great purchases by Germany. Indeed, one rumour credited the Fatherland with having purchased the sole remaining English stocks. This is, doubtless, an exaggeration, though there is some slight foundation of truth in the statement.

### Pig Iron Firm.

The only concession in Midland or Staffordshire pig iron prices to-day was a concession of 1s. per ton on forge iron, and this reduction was only allowed by makers who were not so heavily booked forward as the majority. Current quotations may be fairly given as:—Staffordshire forge qualities: common, 59s.; part-mine, 61s. to 63s.; best all-mine, 87s. 6d. to 92s. 6d.; cold blast, 115s. Northamptonshire, 60s. to 61s.; Derbyshire, 62s. to 63s.; North Staffordshire, 63s. to 64s.

### Manufactured Ironmasters Busy.

Manufactured ironmasters are busy, and orders are still arriving. Neither is there much difficulty in securing specifications for the delivery of the iron ordered. At the moment there is a tendency doubtless on the part of buyers to ask for smaller deliveries, owing to the nearness of the end of the quarter. But his is a temporary trade feature which will soon right itself. Any check which business in North Staffordshire may have received through the increase in the price of bar iron from £7 15s. to £8 is a matter of indifference, as the order books are sufficiently well filled to afford steady employment for some time ahead. South Staffordshire bars are quoted:—Marked bars, £9; Earl of Dudley's brand, £9 12s. 6d.; second grade, £8; and unmarked bars, £7 5s. to £7 15s. per ton. Not much is being done in gas-tube strip or hoop iron, and values still stand at £7 15s. to £7 17s. 6d. for the former and £8 10s. for the latter. Rivet iron is consistent at £7 15s., and slit nail rods £8 10s.

### Sheet Iron Unimproved.

The sheet iron position is unimproved. Black sheets do not give any sign of increased strength, but values of galvanised material are well upheld. Black sheets are selling at:—Singles, £8 12s. 6d. to £8 17s. 6d.; doubles, £8 15s. to £9; trebles, £9 7s. 6d. to £9 10s. Galvanised material has just been reaffirmed by the Makers' Association in this trade at £13 17s. 6d. f.o.b. Liverpool, or equal distance outports for export.

### Steel.

Steel quotations were exceptionally firm. As much as £6 7s. 6d. was asked for Bessemer billets, though some firms would take £6 5s. per ton. Siemens billets were £6 7s. 6d. to £6 10s. Manufactured steel was quoted:—Mild bars, £8 to £8 5s.; girder plates, £8 to £8 5s.; boiler plates, £9 2s. 6d. to £9 5s.; joists, £7 5s. to £7 7s. 6d.; angles, £7 5s. to £7 10s. Steelmakers entertain no anxieties respecting the absorption of their full output for some time ahead. Railway wagon building material locally is particularly brisk. There has been no attempt on the part of local makers of angles to follow the Scotch example of raising angles 5s. per ton.

## NOTES FROM LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, June 26th.

### Is there a Decline in the Pig Iron Boom?

THIS question is more easily asked than answered. The opinions expressed on the Manchester Iron Change on Tuesday were so varied that it was difficult to arrive at a satisfactory conclusion. Makers who have little iron to sell view the situation with something of indifference, but merchants and consumers generally seem inclined to the view that the "boom" has to some extent spent itself. All depends, of course, on the demand from America and Germany. While accounts from the States are, to say the least, indifferent, the feature reported last week was the steady buying from Germany. On Tuesday operations in crude iron were of a very limited character, and prices in this department were more or less nominal. Middlesbrough brands had again a tendency to approximate more to warrant prices, which, however, showed some improvement at the close of the day. West Coast hematite was offered at less money, but East Coast was generally unchanged. Scotch iron was generally a shade better, but Lincolnshire, Staffordshire, and Derbyshire ruled in buyers' favour, what little there was offering. Forge iron, in sympathy with foundry, was about 1s. per ton under last week's quotations. We should say that altogether there is a more confident feeling, but whether we shall see a return to high prices can only be determined by the sealed book of the future.

### Finished Iron.

There was more business reported at full prices.

### Steel.

There is more firmness, although there is little change to note in prices. Sheets appear to be in strong inquiry, and for prompt delivery a premium has been paid for small quantities of 10 to 20 tons. In billets there is again talk of an influx of German stuff, but English makers report themselves well sold, and accept full rates only.

### Copper.

Both raw and manufactured ruled lower, and the outlook was none of the brightest. Sheets are quoted £3 per ton lower, and both copper and brass tubes have shared in the reduction.

### Sheet Lead.

About 15s. to 20s. per ton lower.

### Quotations.

Pig iron: Lincolnshire, No. 3 foundry, 65s. 6d. to 66s.; Staffordshire, 65s.; Derbyshire, 66s.; Middlesbrough, open brands, 65s. to 65s. 4d. Scotch: Gartsherrie, 77s. 6d.; Glengarnock, 76s. 6d.; Eglinton, 73s. 6d.; Dalmellington, 73s., delivered Manchester. West Coast hematite, 78s. to 79s., f.o.t.; East Coast ditto, 80s., f.o.t. Scotch, delivered Heysham: Gartsherrie, 75s. 3d.; Glengarnock, 74s. 3d.; Eglinton, 71s. 3d.; Dalmellington, 70s. 9d. Delivered Preston: Gartsherrie, 77s. 6d.; Glengarnock, 75s. 6d.; Eglinton, 72s. 6d.; Dalmellington, 72s. Finished iron: Bars, £8; hoops, £8 7s. 6d.; sheets, £8 15s. to £9. Steel: Bars, £8; hoops, £8 15s.; sheets, £9 to £9 5s.; boiler plates, official, £9 2s. 6d.; plates for tank, girder, and bridge work, £7 15s.; English billets, £6 5s. to £6 7s. 6d.; foreign ditto, £6. Copper: Sheets, in quantity, £113 per ton; small lots, 14d. per lb.; tough ingot, £105; best selected, £105 per ton. Seamless copper tubes, 13½d.; seamless brass tubes, 10½d.; condenser, 11½d.; brass wire, 9½d.; rolled brass, 9¾d.; brass turning rods, 9½d.; yellow metal, 9d. per lb. Sheet lead, £24 5s. 10s. per ton. English tin ingots, £190 to £192 per ton.

### Lancashire Coal Trade.

The attendance on the Coal Exchange on Tuesday was well up to the average, but trade on the whole was somewhat quieter, although prices generally showed little change. There was a fair demand for slack, but house coal was quiet. Coal for bunkering purposes was in good request, with prices firm, and in sellers' favour.

BARROW-IN-FURNESS, June 27th.

### Hematites.

The business being done in hematite iron during the week has been comparatively small, and the inquiry has fallen off not only on American but on home and continental account, and there is not much prospect for a week or two, at any rate, of any change for the better. In the meantime, makers of iron are very well employed, and they are likely to remain so for some time, even if new orders do not come in. The opinion is, however, that the market will soon correct itself, as it is known that the actual demand for iron has only been temporarily checked by causes outside of the market itself, but as to how long it will be before any reviving influences are set to work remains to be seen. Makers have reduced their prices 6d. per ton, and are now asking nominally 81s. 6d. per ton net f.o.b. On the other hand, the price of warrant sellers is 76s. net cash, buyers 3d. less. There is, however, very little if any iron offering at this price, and the market has been strengthened statistically by a further clearance of warrant iron during the week; 2235 tons have been taken out of store, and the stocks now represent 25,083 tons. Makers remain practically without stocks, and many of them are behindhand with their delivery engagements. The position of the special trade in hematites of superior quality, ferro-manganese, spiegeleisen, and charcoal iron are all very satisfactory. Iron ore commands a good market, and prices are at 17s. 6d. net cash at mines for good average sorts.

### Steel.

Full activity prevails at the rail and plate mills in the district, and it is expected that further orders will soon be booked in both branches. The demand for merchant steel is very quiet, and the mills are only occasionally at work. Heavy steel castings are in fairly good demand, and there is a steady trade at the iron-founding establishments in the district and at the brass-founding works, while the trade being done in chilled iron castings is very steady, and orders come in freely.

### Shipping and Coal.

The shipments of iron and steel from the West Coast ports amounted to 8137 tons—iron, 4015 tons; and steel, 4122 tons—as against 24,137 tons for the corresponding period of last year—a decrease of 16,000 tons. The shipments of the year to date aggregate 445,689 tons, as against 377,038 tons for the corresponding period of last year—an increase of 68,651 tons. The coal and coke trades are very firm. East Coast coke is quoted at 25s. 6d. per ton, delivered.

## THE SHEFFIELD DISTRICT.

*(From our own Correspondent.)*

### House Coal.

THERE are no signs of any weakening in house coal values, and though July is at hand present quotations are unlikely to be altered just yet. The output was considerably reduced last week owing to the Yorkshire miners' demonstration at Barnsley, and it will be further restricted as the various "feast" days, with the inevitable "play," come round in the colliery districts. Barnsley thick seam house coal, in best qualities, is quoted up to 11s. and 11s. 3d. per ton, secondary sorts from 9s. 6d. to 10s. at the pits. A fairly active business is reported from nearly all markets.

### Gas and Steam Coal.

Contracts for gas coal are being renewed pretty freely at the higher rates now required. Gas coal seems to be stiffer. The arrangements now being made are from 2s. 6d. to 3s. per ton above the contract rates expiring this month. The railway companies are also coming to arrangements for locomotive coal, though not so readily as in the case of gas companies and corporation gas departments. The contracts are usually made from June to June, but railway companies are indicating a preference for a shorter period. The coalowners stand stiffly by the rate at which they have tendered—12s. per ton. A heavy tonnage is being sent to the seaboard, both Hull and Grimsby taking freely. To Hull there was sent during the week ending June 18th a weight of 91,527 tons, compared with 50,728 tons for the corresponding week of last year. In the open market best Barnsley hard fetches more than the rate asked under the new contracts, 13s. per ton being frequently quoted, and prices of other kinds of steam coal in sympathy.

### Small Coal and Coking Fuel Firm.

The exceptional demand for coking fuel noted last week is fully sustained. The ovens are constantly on the increase, and a market is readily found for all the coking slack and smudge produced. The quotations for good brands, up to 7s. per ton at the pits, are easily obtained. In manufacturing fuel for engine purposes an advance has to be recorded this week, 6s. to 7s. per ton being now quoted at the pits. Owing to the activity in the cotton trade, the requirements of Lancashire are large, and there is brisk business also reported with the textile districts of Yorkshire, as well as with the markets. Coke is being heavily forwarded to North Lincolnshire, Derbyshire, and other iron-smelting localities. The demand generally is exceedingly active and quite equal to the output, large as it is. Best smelting coke, 17s. to 17s. 6d. per ton; unwashed, 14s. 6d. to 15s. 6d. per ton at the ovens; for steel melting coke the quotation is maintained at 27s. to 28s. per ton.

### Iron still Firm.

We can find no evidence of weakening of iron values in this district. There is very little buying reported, but, as a matter of fact, makers are so busy sold forward they have little to sell. Quotations exhibit no alteration on former rates, being as follows:—West Coast hematites, 92s. to 93s. per ton; East Coast, 88s. to 90s. per ton—both delivered in Sheffield and Rotherham, and East Coast subject to 2½ per cent.; Lincolnshire, No. 3 foundry, 64s. 6d. per ton; No. 4 foundry, 62s. 6d. per ton; No. 4 forge, 61s. 6d. per ton; No. 5 forge, mottled, white, and basic, 65s. 6d. per ton; Derbyshire, No. 3 foundry, 63s. per ton; No. 4 forge, 60s. per ton; bars, £8 5s. to £8 10s. per ton; sheets, £9 10s. to £10 per ton.

### Railway and Marine Material, &c.

The steel manufacturers are generally well engaged in all their leading departments, more especially in the higher grades and special steels. Engineering houses continue to be satisfactorily employed. In railway material rather more work is being placed on home account, while the foreign and colonial requirements, particularly in tires, axles, springs, &c., are steadily maintained. We do not hear, however, of much new work in large forgings and castings for marine purposes, but there is increasing business in lighter forgings and castings, such as are required for electrical machinery. It is a long time since file manufacturers were so busy, both for home and foreign markets. There is also a good demand for various classes of edge tools.

### Derwent Valley Waterworks.

Record stones were laid in the great walls of the Derwent and Howden dams, on the 21st inst., by Alderman T. R. Gainsford, Sheffield, the chairman of the Derwent Valley Water Board.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Cleveland Iron.

A VERY desirable change has this week come over the Cleveland pig iron market, both as regards demand and prices, both of which have substantially improved, and a buoyant tone has sprung up. The advance in the quotations appears to be due to a reaction. It is generally acknowledged that the "slump" in prices was carried too far; there was really no justification for beating down the rate for Cleveland warrants to 54s. 11d. cash buyers, which was the figure last Monday, and the lowest that has been reported since the middle of April. That represented a fall of close upon 7s. per ton since June came in—in a little over three weeks. Traders last week were wondering when the bottom would be reached, and were holding off in consequence, but the advances that have been reported this week have imparted confidence, and buyers are not anything like so timid as they were last week. A good deal of business has been done in Cleveland pig iron this week, and there is a great contrast between the state of the market last week and this. Second-hands were selling No. 3 Cleveland pig iron on Monday at as low a figure as 55s. 9d. per ton, on Tuesday 56s. 9d. was obtained; and on Wednesday 57s. 6d., and the last was the general quotation, except for special brands, for which a premium of 1s. to 2s. had to be given. The makers having plenty of orders did not follow warrant prices down to the full limit, and they looked for a reaction. Consumers on the Continent can well afford to pay the 57s. 6d. for No. 3 Cleveland iron that is now quoted, and they are beginning to buy pretty freely. Altogether the position is the most satisfactory that has been known this month, and a sanguine tone once more prevails. No. 1 Cleveland pig iron is 5s. per ton dearer than No. 3, and Nos. 4 foundry and 4 forge are in most cases realising the same price as No. 3, but in some cases 3d. to 6d. less is accepted. Continental buyers have begun to want No. 4 forge as well as No. 3, and there will be much difficulty in supplying it, as there is no stock and so little is made. America is not buying much Cleveland iron just now, but is receiving large quantities in completion of old orders. Two large steamers are loading at Eston Jetty for the United States—the Angus and the Viscaya—and further tonnage is being sought by the shippers. Large exports to America are assured for the coming quarter.

### Hematite Iron.

The situation is very favourable for producers of East Coast hematite pig iron, who are well supplied with orders, and are little troubled by the operations of speculators, for the latter cannot get any East Coast hematite warrants with which to gamble. Makers and consumers are left pretty well to themselves in regard to the regulation of prices, and there is nothing of the wild fluctuations which has interfered with business in Cleveland iron. While this month Cleveland warrants have been as high as 61s. 10½d. and as low as 54s. 11d. cash, a difference of about 7s. per ton, mixed numbers East Coast hematite iron has moved no more than 6d. per ton, though it is 24s. to 25s. per ton dearer, instead of the usual 10s. This week business has mostly been done at 81s. 6d. per ton for mixed numbers, but it was generally done by second hands; the leading producers hold out for 82s., which the West Coast makers are quoting for their iron. There is an improvement in the price of West Coast hematite warrants, and buyers of them have become somewhat keen. The output of hematite iron is not in excess of the demand, and this enables sellers to keep up their prices. Rubio ore is firm at 22s. 6d. per ton c.i.f. Middlesbrough, and there are heavy imports into the Tyne, Wear, and Tees.

### Heavily Declining Stock of Pig Iron.

This is one of the most important features of the market, and it indicates how much short of the consumption the present production is; indeed, it has been so for months—in fact, since March last year. Makers' own stocks disappeared long ago, and there is a strong run on the stock in Connal's public stores. Up to 26th this month's reduction in Connals was 47,991 tons, 274,235 tons being held of Cleveland pig iron—nothing else is now in store. This stock consisted of 263,188 tons of No. 3, 10,897 tons of No. 4 foundry, and 150 tons of iron not deliverable as standard. The prospects are that the stock will continue to decline heavily for several months yet.

### Manufactured Iron and Steel.

Most producers report an improving demand, though some have to complain that specifications for some old orders do not come to hand so promptly as they might. The tendency of prices is generally upwards, but no actual advances can be reported; this district has not followed some of the others in putting up quotations. It is believed that buying will be more freely carried on now that the threatened labour troubles in the allied industries will, after all, not come off. Consumers have been holding back because of these. Steel ship plates are at £7 10s.; steel boiler plates at £8 10s.; iron ship plates, £7 15s.; packing iron, £6 15s.; iron ship rivets, £8 2s. 6d.; steel joists, £6 17s. 6d.; steel ship angles, £7 2s. 6d.; steel hoops, £7 15s.; steel strip, £7 5s.; steel sheets, singles, £8 15s.; iron bars, £8, all less 2½ per cent. f.o.t. Galvanised and corrugated sheets, 24 gauge, in bundles, are at £13 17s. 6d., less 4 per cent. Heavy steel rails are at £6 15s.; steel sleepers, £7 2s. 6d.; and cast iron chairs, £4 2s. 6d., all net f.o.b.

### Shipbuilding.

There is more animation in the shipbuilding industry; orders are likely to be given out more freely now that the uncertainty is removed with respect to the labour trouble in the engineering industry. Rates of freight are showing improvement, and shipowners are expected to increase their fleets, as there is more than enough work for the steamers that are in existence. In addition to the building of merchant steamers there is a good deal being done on the Tyne in the building and fitting out of war vessels. Sir W. G. Armstrong, Whitworth and Co. are building cruisers for Chili and the Argentine Republic, as well as a war vessel for the British Admiralty; Palmer's have the Lord Nelson in hand; and Messrs. R. and W. Hawthorn, Leslie and Co. are refitting a Portuguese warship. It is reported that the Portuguese Admiralty are about to increase the number of their fleet.

### Coal and Coke.

The greatest briskness prevails in the coal trade of this district, and deliveries are extraordinarily large, as steamers are coming forward more adequately, and collieries are seldom stopped for lack of tonnage. Thus there are few forced sales of prompt coal, and prices are firmer all round. The most prosperous business is that of gas coals, which are in uncommonly large demand for the Continent, for long forward as well as early delivery. Best gas coals have been put up to 14s. 6d. per ton f.o.b., and seconds to 13s. 6d. For coking coal, 13s. 6d. to 13s. 9d. per ton, f.o.b. Tyne Dock, is being realised. The coke manufacturers are getting 23s. to 24s. per ton f.o.b. for foundry qualities, and 21s. for medium qualities for delivery at the Middlesbrough furnaces, and all these prices are relatively a good deal dearer than those of Cleveland pig iron. Furnace coke, with No. 3 Cleveland pig iron at 57s. 6d., should not be over 19s. per ton, instead of 21s.

## NOTES FROM SCOTLAND.

*(From our own Correspondent.)*

### Weakness in the Iron Market.

THERE has been further weakness in the speculative department of the iron market, and lower prices have been

touched. Advices from America have in the main been unsatisfactory, the impression produced by these being to the effect that the demand for our iron is likely to be materially reduced, if it does not altogether cease for the season at least. Now that the holiday time is at hand, the home demand for raw iron has become less urgent. Recently there has been a little more doing with the Continent, and the makers of pig iron are well supplied in the meantime with orders.

### The Warrant Market.

There was a slight improvement in the warrant market towards the end of last week, but the tone became weaker when the market reopened this week, and lower prices have been recorded. Occasionally some buying, with the view, it is alleged, of covering oversales, has rallied the market and arrested the downfall in values, but the general condition is one of irregularity. Business has been done in Cleveland warrants from 55s. to 56s. cash, at 55s. 9½d. to 56s. 5d. one month, and 55s. 8d. for delivery in three months.

### Hematite and Foundry Iron.

There has been comparatively little demand for hematite warrants. Cumberland hematite is nominally at 76s. per ton, Makers of Scotch hematite are very busy, and the present output is probably about the largest on record, being quite up to that of this time last year, when the demand for shipbuilding purposes was so great. It is somewhat doubtful if the makers can calculate on a long continuance of such active work. They have a good proportion of structural material in hand just now, and as shipbuilding is not very hopeful at the moment, much will depend on the state of the general trade in the future. Scotch hematite is quoted by merchants 84s. per ton for delivery at the West of Scotland steelworks. There has recently been a better demand for foundry iron, a fair trade having been done in this quality with makers. Standard foundry pig iron warrants are quoted on Glasgow Exchange 55s. per ton.

### Prices of Makers' Iron.

Several of the ordinary kinds of Scotch makers' pig iron are 6d. to 1s. per ton lower, but there is no change in the values of the special brands. G.M.B., No. 1, is quoted at Glasgow 73s.; No. 3, 69s.; Govan, No. 1, 73s.; No. 3, 70s.; Monkland, No. 1, 74s.; No. 3, 70s.; Carnbroe, No. 1, 75s.; No. 3, 71s.; Clyde, No. 1, 78s. 6d.; No. 3, 73s. 6d.; Gartsherrie and Calder, Nos. 1, 79s.; Nos. 3, 74s.; Summerlee and Langloan, Nos. 1, 81s.; Nos. 3, 75s.; Coltness, No. 1, 90s.; No. 3, 78s.; Glengarnock, at Ardrossan, No. 1, 79s.; No. 3, 74s.; Eglinton, at Ardrossan or Troon, No. 1, 74s.; No. 3, 71s.; Dalmellington, at Ayr, No. 1, 77s.; No. 3, 72s.; Shotts, at Leith, No. 1, 79s.; No. 3, 74s.; Carron, at Grangemouth, No. 1, 82s.; No. 3, 75s. per ton.

### Shipments of Pig Iron.

The shipments of pig iron from Scottish ports in the past week amounted to 7704 tons, compared with 5589 in the corresponding week of last year. To Canada 1170 tons were despatched; United States, 825; Holland, 560; Germany, 485; South America, 535; Australia, 376; Italy, 115; France, 75; Belgium, 20; other countries, 335; the coastwise shipments being 2993 tons, against 3369 in the same week of 1906. The arrivals of Cleveland pig iron at Grangemouth in the past week amounted to 11,494 tons, showing an increase of 939 tons over the quantity received in the corresponding week of last year.

### Finished Iron and Steel.

There has lately been a good inquiry for manufactured steel for export, and the works are in the meantime, well employed. It is understood that shipbuilders have been making some inquiries that may possibly lead to business, but the outlook in the shipbuilding industry at the moment is by no means cheering. The competition with the East Coast of England has recently been somewhat keen for certain kinds of material. Makers of finished iron are well supplied with work at present, but the outlook is not quite clear. Home consumers are purchasing with caution, and makers are dependent to a considerable extent on export business. The Clyde Structural Iron Company, Scotstoun, Glasgow, has received an order from an Austrian firm for the supply and erection of the buildings required for a new shipbuilding yard for Austria.

### Shipbuilding Orders.

Several fresh shipbuilding contracts are reported to have been arranged; one is a 30,000-ton steamship, to be named the George Washington, to be constructed at Clydebank for the Hamburg-American Line. It is understood that this order was practically arranged some time ago with Messrs. Harland and Wolff, of Belfast, and it is now reported that the vessel will be built at Clydebank under the new arrangement between the Clydebank firm and Harland and Wolff.

### The Coal Trade.

There is an active business in the different branches of the coal trade. The past week's coal shipments from the Scottish ports amounted to 313,755 tons, being 6580 tons more than in the preceding week and 46,415 tons greater than in the corresponding week of 1906. The prices of shipping coal are steady. At Glasgow harbour ell coal is quoted 12s. to 12s. 6d., and steam and splint 11s. 6d. to 12s. per ton. Best screened steam coal is quoted at Leith 12s. 6d. to 13s.; washed doubles and trebles, 12s. 3d. to 12s. 6d.; and rough coal dross, 9s. to 9s. 6d. per ton. House coal has continued in good demand for home use in consequence of the unseasonable weather, and the demand for coal for manufacturing purposes is large, the prices showing comparatively little alteration.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

### The State of the Coal Trade.

THE stormy weather which has continued, affecting output and all industries, has been detrimental to the coal trade in a marked degree, and though, fortunately, wrecks in the Channel have not been serious, the incoming of tonnage has been much delayed. Still, I am pleased to note that returns, duly considering these facts, have been satisfactory. Custom House returns show that in the week ending June 21st, 501,035 tons of coal were shipped foreign from the South Wales ports, an increase of 31,700 tons, as compared with the corresponding month. Out of this total Cardiff shipped 343,162 tons of coal, 1570 coke, and 14 000 tons of fuel. In coal, Genoa took eleven cargoes, totalling 55,000 tons; Port Said five, with 29,000 tons. In fuel, Valparaiso took 5000 tons. Newport was fairly busy with 58,662 tons of coal, and 4384 fuel for Catania. The River Plate was the principal destination for coal. Swansea shipped 54,204 tons of coal, 17,500 fuel; principally to San Francisco and Almeria. Rouen and St. Nazaire were principally the destinations of the coal. Port Talbot made a tolerable display, shipping about 45,000 tons, chiefly to Iquique, 13,000 tons, and St. Nazaire, 7000 tons.

### Latest Coal Quotations, Cardiff.

With regard to prices the market is decidedly easier for prompt shipment, owing to the scarcity of tonnage, but for backward shipment sellers are holding out for top prices, as they believe the easiness is temporary. Small steams are easy, and, in fact, for all kinds of coal for prompt shipment buyers can treat at reasonable prices. It is reported that as little as 11s. has been accepted for best smalls, but I cannot get confirmation. The following list may be taken as correct:—Best large steam, 18s. 9d. to 19s. 3d. best seconds, 17s. 3d. to 18s. 3d.; ordinary seconds, 16s. 6d. to 17s.; drys, 16s. 3d. to 16s. 6d.; best washed nuts, 15s. to 15s. 6d.; seconds, 14s. to 14s. 6d.; peas, 14s. to 14s. 3d.; seconds, 13s. 3d. to 13s. 6d.; very best smalls, 11s. 9d. to 12s.; best ordinaries, 11s. to 11s. 6d.; seconds, 10s. 3d. to 10s. 9d.; inferiors, 9s. 9d. to 10s.; best Monmouthshire black vein, 17s. 3d. to 17s. 3d.; ordinary Western Valleys, 16s. 9d. to 17s.; Eastern Valleys, 15s. 3d. to 15s. 9d. Bituminous coal: Best households, 18s. 6d. to 19s. 6d.; best ordinaries, 17s. to 17s. 6d.; No. 3 Rhondda, 20s. to 20s. 6d.; brush, 16s. to 16s. 3d.; smalls, 13s. 3d. to 13s. 6d.; No. 2 Rhondda, 14s. to 14s. 6d.; through, 11s. to 11s. 6d.; smalls, 10s. to 10s. 3d. Patent fuel, 19s. to 19s. 3d. Coke: Furnace, 20s. to 22s.; foundry, 26s. to 27s.; special, 29s. to 31s.

### Anthracite.

Swansea has suffered as much as Cardiff from an absence of tonnage, and buyers have benefited. Still the tone of the market is good, and forward business strong. Best anthracite for malting is 23s. to 23s. 6d.; seconds, 21s. 6d. to 22s.; Swansea big vein, 20s. to 21s.; red vein, 14s. to 14s. 6d.; machine made cobbles, 21s. 6d. to 22s. 6d.; nuts, 25s. 6d. to 27s. 6d.; peas, 14s. to 16s. 6d.; rubbly culm, 9s. 3d. to 9s. 6d.; duff, 6s. to 6s. 6d. Other quotations are: Steam, best large, 18s. 9d. to 19s. 3d.; through bunkers, 12s. 6d. to 13s.; small, according to quality, 9s. 6d. to 10s. 6d. Bituminous, No. 3 Rhondda, 19s. 9d. to 20s. 3d.; small, 13s. to 13s. 6d. Patent fuel, 17s. 6d. to 18s.

### Anthracite Developments.

It is expected that in a short time coal winning will be carried on between Llanelly and Llangannech. French and German buyers are in good supplies, and with fairer weather more trade is certain. Negotiations are pending in regard to the Pencoed colliery.

### Pitwood.

Prices are quiet, at about 19s. 6d. ex ship. The quantity of pitwood imported into the Welsh ports last week was 17,500 tons.

### Large Italian Order for Coal.

The rumour that the Italians had bought largely of American coal is discredited, but it is certain that extensive purchases continue to be made in Wales for delivery during the next two months. Some orders are for second-class Cardiff coal, with large Monmouthshire coal. Prices:—Cardiff coal, 25s., c.i.f.; Monmouthshire, 17s., delivery at Savona or Spezzia.

### Iron and Steel.

On the metal market, Swansea, this week, the following iron and steel prices ruled:—Bessemer pig, mixed numbers, 76s.; Middlesbrough, 55s. 9d.; Scotch, 64s.; Welsh hematite, 85s. to 86s. Steel bars: Siemens and Bessemer, £6 5s. to £6 7s. 6d. Cardiff:—Iron ore: Rubio, 21s. to 21s. 6d.; Almeria, 20s. 9d. to 21s. Rails: Heavy, £6 15s.; light, £7 5s.

### Tin-plate.

Not for some years past, states a manufacturer, has trade been so good and work so regular. All the mills last week were fully engaged, and the demand for finished plate has been so great as to keep all hands fully employed, and tin houses thoroughly brisk. The returns do not alone indicate this, for the storms have been so continuous that much delayed tonnage has been noted. During the week the shipments were limited to 57,934 boxes, while no less than 84,371 boxes came from the mills; the result is that stock shows a total of 130,830 boxes, as compared with 104,393 the previous week. This overplus will, however, it is confidently asserted, disappear with the change in the weather. Last week Newport shipped 130 tons galvanised sheets to Bombay, and to Buenos Ayres 110 tons. Bombay also took 240 tons tin-plates. Out of 2367 tons of black plates sent away by Swansea, St. Petersburg took 1200 tons. Prices remain much about the same. Latest report is "market is quiet, but firm." Latest prices, Swansea: Ordinary sheets, I.C. 20 × 14, 112 sheets, Bessemer, 15s. 1½d.; Siemens, 15s. 1½d. to 15s. 3d.; ternes, 26s.; roofing sheets, £11 10s. per ton; big sheets for galvanising, £11 15s.; finished black plates, £11 5s. to £11 10s.; galvanised sheets, 24 g., £14 2s. 6d. to £14 5s.; block tin, £189. Other quotations, Swansea: Lead, £21 10s.; copper, £95 5s.; silver 31d. per oz.; spelter, £24 10s.

### Carelessness in Coal Pits.

It has been generally the case for mine prosecutions to increase in times of good wages. Last week there was a batch of cases heard at Tredegar. One man was summoned for not keeping his roof carefully propped, and was fined 40s. or fourteen days; another, for keeping a portion unpropped, 30s. or fourteen days; one collier, for allowing a train to run wild, had to pay court fees; and another, for sleeping in the mine when under the influence of drink, 40s. or one month. In most cases offenders not only imperilled their own lives, but those of others.

## NOTES FROM GERMANY.

*(From our own Correspondent.)*

### Iron and Steel in Rheinland-Westphalia.

FROM all the principal trades pretty good accounts are coming in, employment and demand remaining lively and regular, though they are less animated than was anticipated for this time of the year. Inland supplies in pig iron continue insufficient, partly because, owing to alterations and improvements at the blast furnace works, output has been rather lower, in a few instances, than before. English pig iron continues to be very freely bought. The malleable iron market shows a firm tendency, and the outlook is fair. According to the *Dusseldorfer Tageblatt*, the forming of a new Bar Convention is being contemplated. The majority of the bar mills favour the plan, and negotiations will soon take place in Baden-Baden, under the lead of the South German mills. Business generally has improved at the bar mills since last month, and the trade being carried on at present is considered satisfactory for this time of the year.

### Coal and Coke in Germany.

Though arrivals of English coal have been very heavy, they have not tended to relieve the scarcity in fuel, for consumption remains exceptionally strong. In Silesia wagons are already beginning to be as scarce as in the autumn, when winter supplies are being bought. In the last two weeks of May the average output of coal was 7744 wagons per day, which means an increase of 15 per cent. in output as compared with the same period last year. The coke trade is exceedingly firm, and very long terms of delivery have to be asked.

### Austria-Hungary.

Firmness is reported to prevail on the Austro-Hungarian iron market. Both forge and foundry pig are extremely scarce, and in the manufactured iron department bars and plates exhibited unwonted strength last week. Girders are in somewhat dull request, but this has not influenced the condition of prices hitherto. Grey forge pig realises 130 to 135 crowns; hematite, 130 to 133 crowns; spiegeleisen, 10 to 12 per cent. grade, 140 to 150 crowns, all per ton at works. Styrian bars stand at 230 to 240 crowns; boiler plates, 315 to 325 crowns; girders, 242 crowns; tank plates, 275 to 285 crowns, all per ton; tin sheets, 62 crowns per box. Supplies are rather lower than demand on the Austro-Hungarian coal market. Moreover, the output of coke is not equal to the demand, and this accounts for the exorbitant prices that are being asked and paid.

### Steady Employment in the French Iron Trade.

The comparative quietness that has prevailed in the French iron industry during the past weeks has not been without a favourable result, though this may sound strange at first; but the period of quietness enabled the mills to execute all orders of previous booking, and fresh contracts are now meeting with very prompt delivery, and as prospects for the third quarter are favourable the tone all round is remarkably firm. All descriptions of heavy plates for naval and military requirements are reported in strong and rising request, and so are mining plant and agricultural machinery. Rolling stock material is in lively request, and the railway and construction shops report increasing activity. Existing orders for locomotives and wagons, &c., are estimated to amount to 130 million francs, Schneider-Creuzot and the Belgian factories being crowded with work till the end of 1908. Very heavy orders in locomotives have recently been placed with German firms, the largest lot having been placed with Hendschel and Sons, of Cassel, Borsig, Berlin, and the Hanover Machine Factory. Smaller lots of two and three million francs have fallen to the machine factory Esslingen, to Gravenstaden, and to the Saxon Machine Factory, Chemnitz. The agreed prices are higher than those paid by the Prussian State Railways. In pig iron a sound business is done, and a rise of 1f. p.t. has been declared; foundry pig stands at 85f. p.t.; forge pig at 73f. p.t. Quotations for finished iron have not changed since the beginning of the year, and are as follows:—Merchant steel, 210f. to 220f.; rails, 190f. to 200f.; common steel plates, 230f. to 235f.; wire nails, No. 20, 280f. to 290f.; galvanised wire, No. 20, 320f. to 330f., all per ton at works. As the work in the building department is somewhat limited, girders, as well as sectional iron, have been but weakly called for. On the French coal market deliveries, as well as demand in engine and house coal, show an improvement as compared with this time last year, and the business done on home and foreign account is extensive and satisfactory. Production is behind consumption, the latter being uncommonly large. Briquettes, almost neglected but a few weeks ago, are in vigorous demand, and 21f. to 23f. p.t. may be regarded as the minimum quotation for ordinary and best sorts. Exports increase, both in coal and in briquettes. Wagons are scarce, and the Railway Administration has been requested to take measures now, to prevent difficulties later on, such as were experienced in the autumn of last year.

### Quiet Business in Belgium.

For some weeks past a regular but somewhat quiet trade has been done on the Belgian iron market; orders for raw and finished iron come in pretty freely, but for some articles an abatement in demand was felt. Rails, for instance, are in decreasing request. Girders sell regularly at firm prices, and the plate and sheet business is strong and satisfactory, quotations remaining the same as before, both for inland and foreign consumption. The semi-finished steel trade has gained in firmness since the forming of the Belgian Steel Convention. Basic is scarce, and foundry pig has continued in lively request. Scrap iron is scarce. Of the Belgian coal market good accounts are given, both with regard to inquiry and demand.

## AMERICAN NOTES.

*(From our own Correspondent.)*

NEW YORK, June 18th.

THE distinguishing feature of the rail market at this time is the presentation of requirements for trolley line construction for 1908. There are no means of knowing the probable demand for this purpose. In a general way it is known that trolley line construction will be vigorously prosecuted. For some time the railroad companies have, with a few notable exceptions, been quiet. The latest large rail order was for 30,000 tons from the Canadian Pacific, which was placed with the Lackawanna firm because they were in a position to make prompt delivery. The belief prevails that the railroad companies will begin ordering in a large way in the latter part of July.

Just now building material is being freely ordered. Capacity spoken for some time ago is being filled. Specifications are arriving, and the mills are very busy. Structural material is wanted quickly; new and extensive orders are now in sight. Premium prices are paid on much business now being booked. The agricultural implement makers are not concerned over rumours of crop shortages this year, and are boldly rushing in orders for bars for next year's delivery. The aggregate is simply enormous, and the mill people feel perfectly safe in accepting it at present prices, in view of the great increase assured in blast furnace capacity during the next twelve months.

The Cambria Steel Company recently sold the United States Steel Corporation 10,000 tons billets. That concern has placed orders for steel cars which will call for over 100,000 tons steel plates. The rapid transformation in progress from wooden to steel cars by railroads is opening up wide possibilities for the plate mills, and manufacturing enterprise has the matter in hand. The railroad companies will put on steel cars from now on as fast as they can get them. Another plate factor is the coming demand for freight vessels, lake, liner, and coastwise. The American Shipbuilding Company wants about 25,000 tons of plates. Mills are congested, and the only remedy is more plate mills.

Public sentiment is veering around in the direction of less drastic treatment of railroads. The railroad managers have had terrific scoldings from the people, the Press, and legislatures, State and National, and with about the usual outcome.

With the collapse of the longshoremen's strike, liberal shipments of copper are now being made to Europe. For week ending June 13th exports were 6056 tons, and since June 1st 8499 tons. Arrivals of tin since June 1st, 1267 tons, with 1700 tons to arrive this month.

Copper production for May:—United States, Mexico and Canada, 98,500,000 lb., compared with 103,800,000 lb. in May, 1906.

Lead is moderately active.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

MESSRS. STEEL, PEACH, AND TOZER, Limited, notify us of their removal from 49 to 15, Victoria-street, S.W.

MR. CHARLES BRIGHT has removed his office from 21, Old Queen-street, Westminster, to Parliament-chambers, Westminster.

THE firm of Marshall, Fleming, and Jack, engineers and crane builders, Motherwell, has been dissolved by the retiral therefrom of Mr. Alexander Jack, one of the partners. The business will be carried on by Messrs. John Marshall and John Fleming, under the firm name of Marshall, Fleming, and Co..

JUNIOR INSTITUTION OF ENGINEERS.—A summer meeting to the Clyde District will be held from Saturday, June 29th, to July 6th.

CONTRACTS.—Messrs. Bruce, Peebles and Co., Limited, have received from the Wolverhampton Corporation an order for a 500-kilowatt 50-cycle motor converter.—Last autumn the London Fire Brigade augmented their motor appliances by a provision of a self-propelled fire tender, with hose reel and ladder carriage for the first turn out. This was built by Messrs. Merryweather, of Greenwich, and the firm has just received an order for two further vehicles, similar in essential details.

# BRITISH PATENT SPECIFICATIONS.

*Selected and Abridged by* **JAMES D. ROOTS**, *M.I.Mech. E.*

*When an invention is communicated from abroad the name and address of the Communicator is printed in italics.*

*When the abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent-Office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.*

*The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.*

*Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-Office of opposition to the grant of a Patent.*

## STEAM ENGINES AND BOILERS.

11,757. May 19th, 1906.—IMPROVEMENTS IN AND RELATING TO VERTICAL STEAM GENERATORS, James R. S. Hayes, 51, Thornhill-road, Barnsbury, London.

This invention relates to vertical steam generators of the multitubular type comprising a shell in the form of two truncated cones merging into each other at the apices. There are two figures. Fig. 1 is a section. The shell *a* is in the form of two truncated cones *b* and *c* merging into each other at the apices. The fire-box *d* conforms to the lower cone *b* and the smoke-box *e* to the upper cone *c*. The crown of the former is at a distance from the bottom of the smoke-box *e*. The water space *f* is all round the fire-box *d*. An efficient circulation is obtained by the tube *g*. The water-level is selected well up to the upper cone *c*, as indicated at *h*, and in consequence the space intervening between it and the base *i* of the cone *c* or the top of the generator forms the steam space. The shell *a* is surrounded by a casing *k* which runs between the bases *i* and *l* of the two cones—that is to say, the top

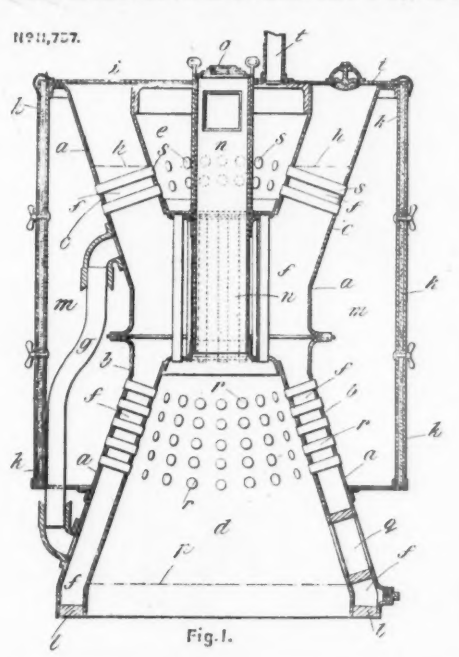


Fig. 1.

and bottom of the generator, and therefore a space *m* of triangular section is obtained all round the shell *a*. The firing tube or tubes may project from the top *i* of the boiler through the smoke-box *e* into the fire-box *d*; *n* denotes the feed tube which is provided with a lid *o*. The dotted line *p* indicates the grate with the fire opening *q*. Two series of fire tubes *r* and *s* are provided, one *r* connecting the fire-box *d* to the space *m* between the casing *k* and the shell *a* and constituting the combustion chamber, and the other *s* connecting the latter, *i.e.*, the space *m* with the smoke-box *e* from which the usual chimney *t* is led. The tubes *r* and *s* are arranged at right angles to the shell *a* and the fire-box *d* and the smoke-box *e*. Consequently the former tubes *r* decline from the combustion chamber *m* to the fire-box *d*, and the others *s* incline from the chamber *m* to the smoke-box *e*. Further, all the tubes *r* and *s* are below the water-level *h*. This arrangement of the tubes *r* and *s* presents many practical advantages, among which may be mentioned ease in expanding the tubes in the plates, facility for cleaning them and keeping them clean, since the dirt tends to gravitate from them, and prevention of overheating due to the tubes being always surrounded with water.—*May 29th*, 1907.

## INTERNAL-COMBUSTION ENGINES.

16,464. July 21st, 1906.—IMPROVEMENTS IN THE VALVE GEAR OF GAS MOTOR ENGINES, John H. Hamilton, Sandiacre, Derbyshire.

These improvements relate to the valve gear of four-cylinder engines. With cylinders operating on cranks at an angle of

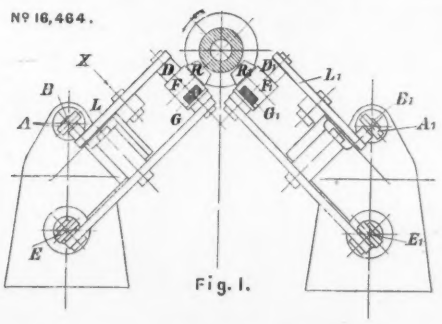


Fig. 1.

180 deg. it is necessary that the cycle of valve movements in any one cylinder shall differ by 90 deg. of the cam shaft motion from that of the adjacent cylinder, the valves of these side-by-side cylinders being operated by the same cams. To obtain this result it was necessary that one pair of levers, viz., the exhaust, should cross, and the object of this invention is to obviate this drawback. Two guides are placed parallel to the cam shaft, and the rollers for operating the valves are attached to crossheads or slippers sliding on these guides. The axes of the rollers would be radial to the cam shaft and those for working the admission and exhaust valves of one cylinder would be in one plane passing through the axis of the cam shaft while the axes of the rollers for operating the valves of the other cylinder would be in another plane, also passing through the axis of the same shaft and at right angles to the former plane. Besides the pin for carrying the roller, each crosshead or slipper would have a slot or recess in which a small block pivoted on the end of the lever for operating the valve would work. The cam would thus cause the crosshead or slipper to slide on its guide, and this in turn would operate one end of a lever, whereof the other end would operate the valve. There are two figures. Fig. 1 represents a cross section behind a pair of cylinders. The admission valves A and $A^1$ are operated by levers L and $L^1$, having at one end blocks B and $B^1$ to connect to the valves, and at the other blocks D and $D^1$, working in slots in the crossheads or slippers F and $F^1$ sliding on guides G and $G^1$, and operated by rollers R and $R^1$ fitting the groove in the admission cam. The parts operating the exhaust valves E and $E^1$ are similar. The centre lines of the rollers pass through the axis of the shaft and are at right angles to one another, so that if the cams revolve in the direction of the arrow the left-hand cylinder leads by 90 deg. on the cam shaft, which corresponds to 180 deg. on the crank shaft of a four-stroke type of engine.—*May 29th*, 1907.

## RAILWAYS AND TRAMWAYS.

12,085. May 23rd, 1906.—IMPROVEMENTS IN OR RELATING TO ANTI-FRICTION MECHANISM FOR RAILWAY TRUCKS AND OTHER VEHICLES, Alexander Spencer, 77, Cannon-street, London.

This invention relates to that kind of anti-friction mechanism for railway trucks and other vehicles wherein the load is transmitted to the running wheel axles through large anti-friction wheels, which bear upon and roll in contact with the ends or journals of the axles, and it has for its object to provide improved means for limiting endways movements of the axles relatively to the anti-friction wheels and axle-boxes. There are three figures. Fig. 2 is a transverse vertical section, partly in elevation; *a* is a running wheel of the truck, *b* the end portion of journal of its axle, and *c c*

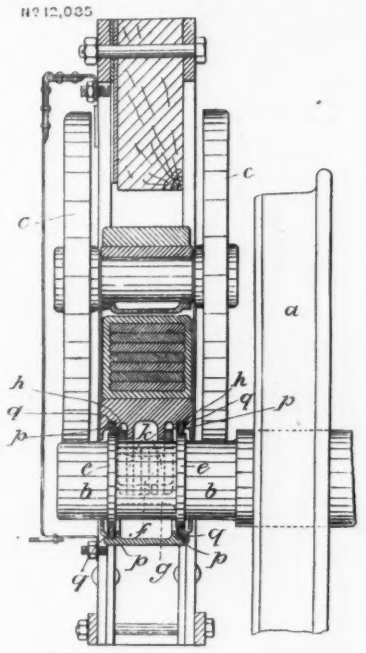


Fig. 2.

are large anti-friction wheels which bear upon and roll in contact with the end portion or journal *b*. The journal *b* is formed with two collars *e*, between which is arranged an abutment device comprising a pair of brasses *f* located at opposite sides of the journal *b*. To hold the brasses *f* in the desired positions out of contact with the journal *b*, they rest upon lower inwardly extending webs *g* of the axle-box, and are connected at their ends by stirrup-shaped members *h*. The brasses *f* closely fit or embrace upper inwardly extending webs *k* of the axle-box, so that they are held firmly in place between the collars, and the end faces act as stops for the adjacent collars *e* of the journal; *p* indicates dust guards that are located in grooves or recesses *q* of the axle-box, and closely surround and bear against the collars of the journal.—*May 29th*, 1907.

## ELECTRIC LIGHTING.

12,325. May 26th, 1906.—IMPROVEMENTS IN ELECTRIC GLOW LAMPS, *Deutsche Gasglühlicht Aktiengesellschaft (Auergesellschaft)*, 139, *Alte Jakobstrasse, Berlin, Germany.*

This invention relates to improvements in electric glow lamps

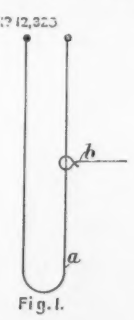


Fig. 1.

having tungsten filaments, and it consists in employing carbon suspenders in place of suspenders of metal or refractory metallic oxides—for example, thoria—which have been hitherto used for suspending other incandescence filaments in electric glow lamps. Carbon possesses the extremely useful property for this purpose of radiating a very large number of heat rays. Consequently, a carbon filament in contact with a white-hot metal filament remains comparatively cool even in the vicinity of the point of contact, and can therefore be made very thin. Carbon of the character of that generally used as the luminous body in ordinary carbon filaments is preferably employed for the purpose. The use of carbon suspenders has been stated to be unsatisfactory for osmium filaments, because of the inevitable formation of osmium carbon compounds, and this invention is based on the discovery that no such objection exists if the filament be of tungsten. There are three figures. Fig. 1 shows such a carbon suspender in the form of a hoop; *a* is the tungsten filament and *b* the carbon suspender. At the point of contact between the luminous body *a* and the suspender *b*, the two may be attached if desired by means of a suitable cement. The carbon filaments used may be of such thinness that they will give to a sufficient extent to the movements of the lamp filament in switching on or off, or when hung aslant, so that the rupture of the filaments is prevented.—*May 29th*, 1907.

## GAS PRODUCERS.

13,703. June 14th, 1906.—IMPROVEMENTS IN AND RELATING TO GAS-PRODUCING PLANT OF THE SUCTION TYPE, Henry N. Bickerton, Philip W. Robson, and the National Gas Engine Company, Limited, all of Ashton-under-Lyne.

This invention relates to improvements in gas-producing plant of the suction type. In such producers as at present constructed it is usual to provide around a hot portion of the producer a vaporising chamber, through which the air supply is drawn and into which water is delivered for supplying the requisite steam for the producer. In the best practice hitherto this vaporising chamber has been filled, or partially filled, with such material as metallic turnings or the like to increase the evaporative surface. It is found, however, that after a while the chamber becomes more or less choked or locally channelled, especially when hard or impure water is used, and it becomes necessary to clear out the chamber and renew the turnings. The chief objects of this invention are to provide a suction producer with an improved vaporising chamber, which may be very easily opened up or removed without breaking any of the principal joints of the producer, and to provide large evaporative surface of a character which shall not become choked or locally channelled when used for long periods even with hard water. There are three figures. Fig. 1 is a vertical sectional view of a producer plant. The producer has a lower body portion *a* consisting of one or more cylindrical parts having at the top a flange *b*, to which the upper flanged portion *c* of the producer is secured by means of the flange *d*, a tight and permanent joint being made at these flanges. The upper portion *c* of the producer is preferably of smaller diameter than the lower portion. The top of the upper portion is provided with a flange *f*, which supports a coal container *g*, a tight and permanent joint being made at this flange also. A coal-feed regulating device *h* of any convenient construction may be mounted upon the top of the coal container. A refractory lining *i* is supported upon a dead plate *j* carried by the lower part of the producer above a closed ashpit *k*. Around the upper portion of the pro-

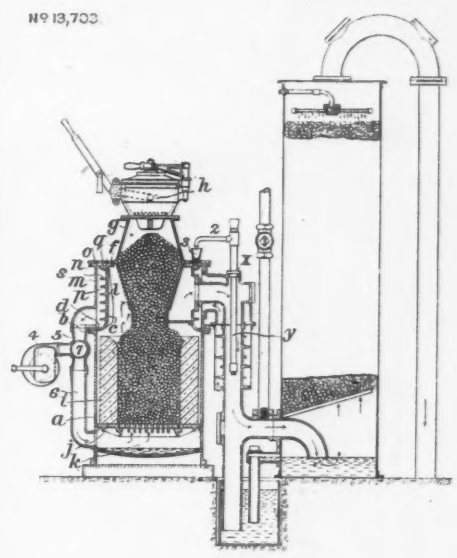


Fig. 1.

ducer there is placed a circular casing *m*, which may be bolted to the lower flange *d* of the upper part *c* of the producer. The top of this casing carries a flange *n*, upon which may be secured a circular plate *o*, which extends across the top of the vaporising chamber *p*, which is formed by this casing and the top portion of the producer. Near the top of the upper portion of the producer there is formed a trough *q*, extending horizontally around the apparatus and projecting into the vaporising chamber. Water to be vaporised is delivered to this trough, the edge of which is provided with a number of "V" grooves or the like, through which the water overflows. Below the trough is a series of horizontal ribs *s*, extending around the producer, each rib being of somewhat greater width than the one next above it, whereby the water trickling down the side of the upper portion of the producer is spread out and is prevented from dripping through more than a short distance. The interior of the upper part of the producer is provided with vertical ribs *t*, which serve to strengthen this part of the producer as well as to extract from the gases heat for transference to the vaporiser. The feed water is heated also by the outflowing gases. This is effected by inserting through a stuffing-box *x* in the outlet pipe a tube *y* closed at the inner end, into which tube is inserted a pipe of smaller bore, after the manner of the well-known "Field" tubes in certain water-tube boilers. The hot feed-water is withdrawn by a pipe 2 at the top of the "Field" tube and delivered to a mouth-piece 3, communicating with the trough *q* of the vaporiser. The fan 4 is connected to the generator in a manner which greatly increases the facility and convenience of starting the plant. The outlet branch of the fan is connected to a junction 5 on the pipe 6, which conveys air and steam from the vaporiser to the ashpit *k*. In the junction piece is placed a deflector 7, which may be placed so as to shut off the vaporiser from the ashpit and establish communication between the vaporiser and the ashpit.—*May 29th*, 1907.

## ROAD MOTOR VEHICLES.

11,511. May 17th, 1906.—IMPROVEMENTS IN OR CONNECTED WITH SELF-PROPELLED VEHICLES EMPLOYING HYDRAULIC POWER TRANSMISSION, Thomas E. R. Phillips, 9, Parr-street, Liverpool.

This invention relates to self-propelled vehicles used on common roads, streets, or on rails in streets or roads, of the type wherein the power given out by the motor—say, an oil or petrol motor—is indirectly transmitted to the driven wheels of the vehicle through hydraulic appliances or mechanisms. There are four

figures. Fig. 1 is a plan showing a combined mechanism; *a* represents the frame of a self-propelled vehicle, and *b* is the prime motor, which may be assumed to be a petrol motor, and of which *c* is the driven crank shaft; *e* is the rotary liquid-forcing apparatus or pump driven by the prime motor and *i* is the hydraulic motor driven by the liquid forced by the pump *e* and of identical form with the pump. These parts, together with the intermediate fluid-controlling and distributing valve, are carried on the frame *a* of the vehicle. The liquid-controlling and distributing apparatus comprises two valves *o p* of similar construction, the valve casing of *o* being connected by a pipe *q* with the discharge branch *j* of the pump, and the valve casing of *p* being connected by a pipe *r* with the return branch *k* of the pump. On the opposite side of the valve case of the valve *o* to the branch *q* there are two pipes, one *s* leading to one branch *y* of the motor *i*, and the other to the other branch *z*. On the opposite side of the valve case of the valve *p* to the conduit *r* there is a conduit *u* connected directly with the

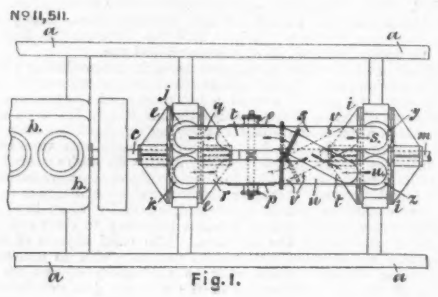


Fig. 1.

branch *z* of the motor *i*, and another conduit *v* connected with the other motor branch *y*. In action, assuming that it is desired to drive at full power in the forward direction, the valve of *o* will be so placed as to cover the entrance of the conduit *t*, and to open fully that of the direct conduit *s*, so that the liquid forced by the motor *e* will pass by this direct conduit through the branch *y* into the motor *i*, and rotate its piston, and the exhaust or return of liquid will take place by way of the branch *z* and the direct conduit *u* through the valve case of the valve *p* back to the return branch *k* of the pump *e*. To reverse, the valve *o* will be moved so that the entrance to the conduit *s* will be closed, and the entrance to the conduit *t* opened, whereupon the liquid will flow by way of this pipe to branch *z*, and so the motor *i* will receive power liquid in the opposite direction, and it will be discharged by way of the branch *y* and the pipe *v*—which is connected to the pipe *s* near this branch—and so on through the valve *p* back to the inlet branch *k* of the pump.—*May 29th*, 1907.

14,539. June 26th, 1906.—IMPROVEMENTS IN VARIABLE SPEED GEARING FOR USE WITH MOTOR CARS AND THE LIKE, James S. Foley, Clifton Villa, 5, High-street, West Bromwich, and Frederick W. Baker, The High House, Old Swinford, Stourbridge.

This invention relates to driving or power-transmitting gear for use as motor-vehicle driving gear of the epicyclic type, in which a worm and worm wheel are employed for transmitting motion. There are four figures. Fig. 1 is a sectional plan. Fig. 2 is a sectional front elevation. The driving shaft *a* is secured to a cage or carrier, and in alignment with the shaft *a* is mounted a driven shaft *b*, having at its inner end a sun or central pinion *c*. The carrier comprises a plate *d* formed with the shaft *a*, and a cylin-

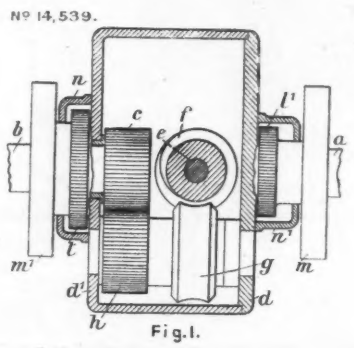


Fig. 1.

drical case $d^1$, which is attached to the plate *d* and journalled upon the driven shaft *b*. Upon a spindle *e* carried in bearings $d^2$ and arranged diametrically across the carrier are a worm *f* and a worm wheel *g* formed with or secured to a planet pinion *h*, which gears with the driven sun pinion *c*. At one end of the worm *f* is a bevel pinion *i*, and engaging with the latter is a pinion *j* rotatable by either of a pair of plain pinions $k k^1$. The latter respectively gear with central pinions $l l^1$, which may be held stationary by any ordinary braking device acting upon the discs $m m^1$. All the gear sets, comprising the worm wheel *g*, pinion *h*, bevel pinions *i* and *j*, and plain pinions $k k^1$, are mounted on the carrier, and the central pinions $l l^1$, as well as the planet pinions $k k^1$, are enclosed in cases $n n^1$. The action of the various sets of gear is to impart or tend to impart to the pinion *c* and the driven shaft *b*, with which it is formed, a rotation in a contrary direction to that imparted by the rotation of the whole mechanism with the carrier. The rotation of the driven shaft when the sets of gear are in action is therefore the resultant of two components, consisting of the forward rotation of the carrier and the rearward action due to the rotation of the planet pinion *h* on its own axis. When the first-named component exceeds the second component, a forward rotation of the driven shaft *b* at a lower rate than the driving shaft *a* is produced; but when the second exceeds the first, the rotation of the driven shaft is reversed. With both discs *m* and $m^1$ free, the whole of the mechanism rotates *en masse*, and no relative or independent movement is set up in the planet pinion *h*. The shafts *a* and *b* rotate

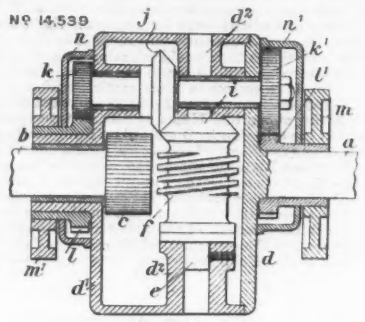


Fig. 2.

in consequence at the same speed. On holding the disc *m*, the planet pinion *h* is rotated on its own axis, and the shaft *b* is driven at a slower rate than *a*. On liberating *m* and holding $m^1$, a further reduction ensues.—*May 29th*, 1907.

26,174. November 19th, 1906.—IMPROVEMENTS IN FRICTIONAL DRIVING GEAR, *Carlo Campo*, 38, *Via Artisti, Turin, Italy.*—*Date under International Convention, November 24th*, 1905.

This invention has for its object the transmission of motion from one driving shaft to two other shafts, and is especially suitable for driving the wheels of a vehicle. This arrangement, which is particularly suitable for automobiles, offers great facilities for obtaining variations in speed and for reversing. There are five figures. Fig. 1 is a plan of the invention; 1 is the frame of the machine. The frame carries two shafts, turning in suitable supports and connected to shafts 3 and 4, carrying the chain wheels 5

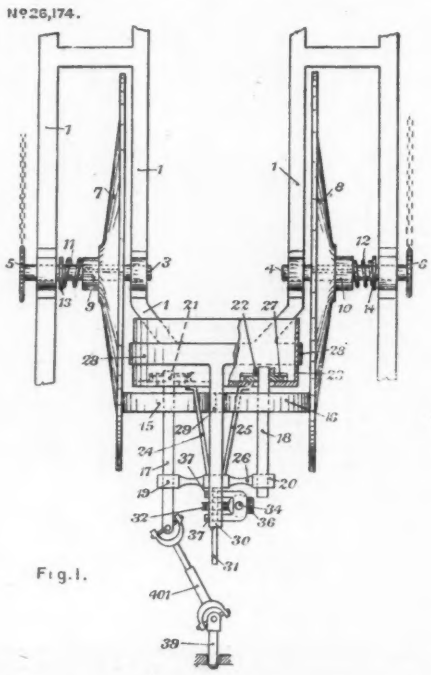


Fig. 1.

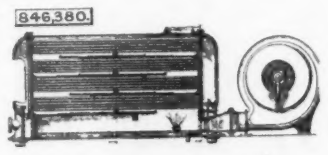
and 6, which are connected to the wheels of the vehicle. Two discs 7 and 8 are keyed to the shafts, and are free to move axially upon them. This result is obtained by any suitable arrangement, such as grooves and feathers 9 and 10. The shafts 3 and 4 are surrounded by springs—for example, by spiral springs 11 and 12, which press both against the hubs of the discs 7 and 8 and also against abutments 13 and 14, thus pressing the discs towards each other. The discs 7 and 8 cause two friction wheels 15 and 16 to press against each other. These wheels are keyed upon the spindles 17 and 18, and turn in suitable bearings 19, 20, 21, and 22. The bearings 21 and 22 are mounted upon a drum-shaped support 23. The drum 23 is rigidly connected by means of arms 24 and 25 to the crosshead 26, which carries at its ends the bearings 19 and 20. The bearings 21 and 22 (or one of them) are mounted upon the support 23 in such a manner as to be capable of a slight displacement. This may be attained by causing the bearing to pass through guides, such as 27, with the object of allowing a slight displacement of the friction wheels 15 and 16 under the effect of the pressure exerted upon them by the discs 7 and 8. The bearings 19 and 20 should be made so as to allow a certain amount of play to the spindles 17 and 18. The drum support 23 turns in the collar 28 fixed to the frame 1. This collar carries a fixed arm 29, which is bent in such a manner as to form at its lower end a kind of support provided with a hole, through which freely passes a spindle 31 fixed to the crosshead 26. Upon this spindle 31 is keyed a worm wheel 32 gearing with a worm fixed to a vertical shaft 34, the upper end of which terminates in a hand wheel. The shaft 34 can turn in bearings formed in a lever 36, whose lower end terminates in a fork, the arms 37 of the fork being pivoted to the spindle 31. The upper portion of the lever 36 may be fixed in notches formed in a guide or quadrant fixed to the frame of the machine. By removing this lever from the quadrant it can be moved laterally by hand in order to rotate the spindle 31, and, consequently, the crosshead 37 fixed to this spindle and the whole system carrying the spindles 17 and 18 and the friction wheels 15 and 16 is turned. The support 23 turns in the collar 28, whilst the spindle 31 turns in a bearing 30. Upon the turning of the whole system the wheels or friction wheels 15 and 16 are no longer in contact with the discs 7 and 8, so that the whole system can be moved forwards or backwards by pressing down the lever 36. The spindle 31 then slides longitudinally in its bearing, whilst the drum 23 also slides longitudinally in the collar 28. By causing the friction wheels 15 and 16 to approach or pass further from the centre of the discs 7 and 8 the speed is either increased or diminished. When the system is in the desired position the lever 36 is brought back into its vertical position, and it is evident that the friction wheels will again immediately come into contact with the discs 7 and 8, so that the transmission of motion continues at the new speed. One of the spindles 17 is connected to the driving shaft 39 through a telescopic shaft and a cardan joint 401.—*May 29th*, 1907.

## SELECTED AMERICAN PATENTS.

*From the United States Patent-office Official Gazette.*

846,380. CONDENSER, *C. A. and F. D. Schwartz, Chicago, Ill.*—*Filed September 13th*, 1905.

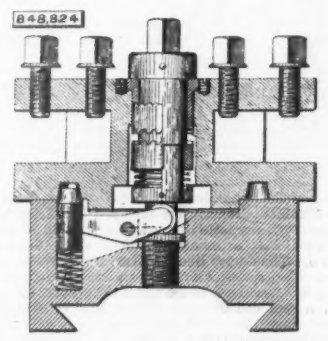
This is an air condenser, the efficiency of which is augmented by moistening the air by means of spraying jets. The claims, eight in number, are for an air drum containing a plurality of longitudinal partitions, dividing it into an air-blast-steadying trunk open at




one end only and a tortuous longitudinal air passage, in combination with groups of tubes, steam admission and exhaust heads communicating with the tubes, and air-moistening means provided in said air trunk and a blast fan for delivering air to said trunk.

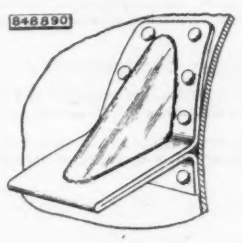
848,824. TURRET TOOL POST, *G. E. Greenleaf, Plainfield, N.J., assignor to Niles-Bement-Pond Company, Jersey City, N.J.*—*Filed September 6th*, 1906.

Ratchet gear is applied to the locking bolt as shown, so that the




tool can be fixed by the backward and forward motion of the spanner. There are three claims for details.

848,890. BOILER BRACKET, *J. J. Fletcher, Toronto, Ontario, Canada.*—*Filed October 23rd*, 1906.




The drawing sufficiently explains this invention. The bracket is made by stamping steel plate. There is one claim.

END OF VOL. CIII.

GENERAL LIBRARY,
UNIV. OF MICH.
10 1907


# The Engineer.

Registered as a Newspaper

OFFICE FOR ADVERTISEMENTS AND PUBLICATION, 33, NORFOLK STREET, LONDON, W.C.

VOL. CIII.—No. 2687] LONDON: FRIDAY EVENING, JUNE 28, 1907 [PRICE SIXPENCE


## War Department.—

TENDERS are invited for the PURCHASE of a FULLY-EQUIPPED CORNISH BOILER, 10ft. long by 4ft. 6in. diameter, fine tubes 2¼ in. diameter, and in good condition, fitted with Annan's patent fire-bars, deadweight safety and Hopkinson's auxiliary valves, the usual mountings, and suitable for a working pressure of 60 lb. per square inch.

The boiler is dismounted, and can be seen on application to the Division Officer, No. 1, Napier Lines, Colchester, where Tender forms and conditions of sale may be obtained, during the hours of 10 and 4 o'clock daily, Sundays excepted (Saturdays 10 to 1 o'clock).

Tenders must be delivered not later than 12 noon on Wednesday, the 10th day of July, 1907, addressed to the Commanding Royal Engineer, Colchester, and marked on the outside "Tender for Boiler."

F. A. K. WHITE,
Capt. R.E.
1151 D.O. Colchester (1).

## War Department Contract.

—SALE OF ABOUT 6160 SUPERFICIAL YARDS OF GLAZED ROOFS.

Notice is hereby given that TENDERS are REQUIRED for the PURCHASE and REMOVAL of THREE GLAZED ROOFS, each covering an area of 231ft. by 80ft.

The roofs are fixed over the space between barrack blocks in Infantry Barracks, Wellington Lines, Aldershot, and are about 43ft above ground level.

The tenderer will have to take down the roofs, providing all necessary tackle, &c., for so doing.

Each roof is constructed on the ridge and furrow system, with 21 oz. sheet glass, in wooden skylights, supported on eleven wrought iron lattice girders, 80ft. long, cast iron valley gutters, &c., wrought iron side louvres, complete as *in situ*.

Persons desiring to make an offer must submit their Tender on a form to be obtained from the Commanding Royal Engineer, South Aldershot, from whom all further information desired can be obtained.

Tenders are to be forwarded to the Major-General in Charge of Administration, Headquarters Office Aldershot, not later than 12 o'clock noon on Monday, the 15th day of July, 1907.

ALEX. H. COWIE, Lt.-Colonel R.E.,
Commanding Royal Engineer, South Aldershot.
Royal Engineer Office,
Headquarters Office, Aldershot,
25th June, 1907. 1113

## Assistant Maintenance

ENGINEER REQUIRED IMMEDIATELY for the Sierra Leone Government Railways for two tours, each of 12 months' residential service. Salary £350, rising annually by £10 to £400 per annum, with free single quarters; first-class passage out and home again on satisfactory termination of engagement. Half pay on voyage out; two months' leave on full pay after twelve months' service, increased to four months if returning to Colony, also full pay during voyage or voyages.

Candidates must be between 25 and 35. They should have been articled to a Civil Engineer, and be experienced in setting out bridges, buildings, permanent way, and other works; thoroughly acquainted with principles and practice of surveying; proficient in use of theodolite and level; good mathematicians and draughtsmen.

Strict medical examination and vaccination if necessary.

Applications (no special form required), stating age, whether married or single, giving particulars of experience, accompanied by copies (not originals) of testimonials will be received by the CROWN AGENTS for the COLONIES, Whitehall-gardens, S.W., up to 9th of July.

Quote M 2792, and name of this paper on letter of application. 1152

NOTICE.

## The British Oxygen Co., Ltd.,

the owners of the Linde and Hampson patents for the production of Liquid Air and the separation of Oxygen and Nitrogen from Liquid Air, HEREBY GIVE NOTICE that they have taken legal proceedings against the Liquid Air Power and Automobile Co of Great Britain, Ltd., to restrain infringement of the said patents

FURTHER NOTICE IS HEREBY GIVEN that, as owners of the above patents, the British Oxygen Co., Ltd., CLAIM EXCLUSIVE RIGHTS in the SEPARATION of OXYGEN and NITROGEN by the RECTIFICATION of LIQUID AIR, and they will take proceedings against all persons infringing these rights. 2009

NOTICE.

## Notice is Hereby Given that

the BRITISH LIQUID AIR COMPANY, Limited, was REGISTERED UNDER the COMPANIES' ACTS on the 18th day of April, 1907, for the Manufacture and Sale in Great Britain of Liquid Air, Oxygen, and Nitrogen, under the patent rights to which the said company is entitled.

Farther information as to the company will be found in its commercial advertisement in another column of this paper.

Dated this 11th day of May, 1907.

LAWRANCE WEBSTER, MESSER and TAYLOR,
14, Old Jewry-chambers, London, E.C.,
Solicitors for the said company. 609

ELECTRICAL ENGINEERING.

## The Electrical Standardising,

TESTING, and TRAINING INSTITUTION (Established in 1889).

FARADAY HOUSE,
64-70, SOUTHAMPTON-ROW, LONDON, W.C.

Chairman—The Rt. Hon. the Earl of CRAWFORD, K.T.
Principal—HUGH ERAT HARRISON, B.Sc., M.I.E.E.
Mathematics—ALEXANDER RUSSELL, M.A.
Chemist—J. THOMAS, B.Sc.
Engineer—WALTER H. BELL, A.M.I.C.E.

Affords a thorough PRACTICAL and THEORETICAL TRAINING in MECHANICAL and ELECTRICAL ENGINEERING for the sons of gentlemen. It is connected with a large number of engine builders, electrical manufacturers, power supply stations, and railways, to provide its students with practical experience.

For prospectus apply to the BURSAR. 862

## Borough Polytechnic Institute,

103, BOROUGH ROAD, LONDON, S.E.

The Governors of the Institute will REQUIRE in September the services of an ASSISTANT LECTURER and DEMONSTRATOR in the Mechanical Engineering Department, for day and evening work. Commencing salary, £115 per annum. Copies only of not more than three testimonials to be sent. Particulars and terms of appointment on application enclosing stamped addressed envelope.

1172 C. T. MILLIS, Principal.

## City of Birmingham.—Municipal

TECHNICAL SCHOOL.

The SERVICES are REQUIRED in September next of TWO LECTURERS in Mechanical Engineering subjects.

Salary: Post A, £150; Post B, £100.

The date for sending in applications is the 1st July, 1907.

Full particulars of the posts will be sent on application to

GEO. MELLOR,
Secretary.
Offices of the School,
Suffolk-street,
6th June, 1907. 951

## Queen's College, Belfast.—Engineering School.

WANTED, an ASSISTANT to ACT as INSTRUCTOR in Engineering Drawing, Descriptive Geometry, and Perspective; in surveying and Setting-out Civil Engineer's Work; to act as Demonstrator in the Engineering Laboratory; and to superintend the Drawing-office work.

Salary, from £125 to £150 per annum, according to qualifications.

Duties begin October 1st, 1907.

Apply to Professor FITZGERALD, Queen's College, Belfast, Ireland, up to July 15th, enclosing copies of testimonials, and specimens of drawings executed by the candidate himself. 1148

## Battersea Polytechnic, London, S.W.

The Governing Body desire to APPOINT a HEAD of the DEPARTMENT of MECHANICAL ENGINEERING and BUILDING TRADES, to commence in September.

For salary, duties, and other information, apply not later than July 8th, to the SECRETARY, Battersea Polytechnic, S.W. 1150

## County Borough of Barrow-in-Furness.

TECHNICAL SCHOOL.

The Education Authority for the Borough REQUIRE the SERVICES of a PRINCIPAL for the Technical School.

The gentleman appointed will be required to undertake, under the direction of the Director of Education, the organisation, equipment, and management of all departments of the Technical School; to take part in the instruction there given, and to advise, when required, on the preparatory technical work undertaken in the Evening Continuation Schools.

Salary, £350 per annum.

Enquiries for further information, if required, may be addressed to the Director of Education, Town Hall.

Applications, furnishing particulars of professional and technical training, experience in teaching and organisation, together with copies of 3 recent testimonials, references, &c., should be forwarded on or before Monday, 1st July, 1907, to the undersigned, and be endorsed "Principal of Technical School."

By order,
C. F. PRESTON,
Town Clerk, and Clerk to the Local Education Authority.
Town Hall, Barrow-in-Furness,
10 h June, 1907. 1133

## Middlesex Education Committee.

The Edmonton Local Committee for Technical Instruction invite APPLICATIONS for the POSITION of TEACHER for the following CLASSES:—

Machine Construction and Drawing.
Patternmaking.

Full particulars as to qualifications and fee required for one evening per week of two hours, with copies of three recent testimonials, to be sent not later than July 8th, to E. M. ANDREWS, Cecil-road, Enfield. 1137

## University College of South Wales and Monmouthshire.

Coleg Prifathrofol Deheudir Cymru a Mynwy.

The Council of the College INVITES APPLICATIONS for the POST of PROFESSOR of MINING at the annual salary of £600.

Further particulars may be obtained from the undersigned, to whom 100 copies of applications, together with testimonials, must be sent on or before Thursday, 11th July, 1907.

J. AUSTIN JENKINS, B.A.,
Registrar.
University College, Cardiff,
11th June, 1907. 1023

## East Surrey Water Company.—

SALE OF ORDINARY SHARES BY TENDER.

Notice is Hereby Given that it is the intention of the said Company to SELL by TENDER SIX HUNDRED ORDINARY SHARES of £10 each, of and in the East Surrey Water Company.

The last day for the reception of Tenders will be Friday, the 26th day of July next, at 12 o'clock at noon.

Forms of Tender, with particulars of sale and conditions of Tender attached, can be had upon application at the Company's office, Redhill, Surrey.

By order,
A. E. CORNEWALL-WALKER,
Secretary.
Redhill, Surrey,
21st June, 1907. 1136

## Bristol Docks. — Avonmouth Dock Works.

MOVABLE ELECTRIC JIB CRANES.

The Docks Committee of the Council of the City and County of Bristol are prepared to receive TENDERS for the CONSTRUCTION, DELIVERY, ERECTING in PLACE, FITTING, TESTING, and MAINTENANCE for twelve months after completion of the following ELECTRIC JIB CRANES to be erected at the Royal Edward Dock now in course of construction at Avonmouth, in the Port of Bristol:—

SCHEDULE No. 1.—Twelve 10 Cwt. Movable Electric Jib Cranes to be erected on the roofs of Sheds No. 1 and No. 2, in course of construction on the east side of the Dock.

SCHEDULE No. 2.—Two 10-Ton Movable Electric Jib Cranes on high pedestals to be erected on the Wharf on the south side of the Dock.

SCHEDULE No. 3a.—Three 30 Cwt. Movable Electric Jib Cranes on high pedestals to be erected on the Wharf on the south side of the Dock.

SCHEDULE No. 3b (as an alternative to Schedule 3a).—One 30 Cwt. Movable Electric Jib Crane.
Two 3-Ton Movable Electric Jib Cranes.

Tenders will be considered only from firms who have done similar work before, and tenderers will be required to state what work they have done of a similar nature.

On and after Monday, 1st July, 1907, copies of the specification, form of Tender, form of contract, and copies of the contract drawings can be obtained from the undersigned on production of a receipt from the Secretary of the Docks Committee showing that £5 has been paid as deposit. The deposit of £5 will be returned to bona fide tenderers after receipt of a Tender accompanied by all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope, and endorsed "Tender for Electric Cranes," and addressed to the Secretary of the Docks Committee, Dock Offices, 19, Queen-square, Bristol, and must be delivered to him, accompanied by the prescribed documents, before 10 a.m. on Friday, the 26th July, 1907.

Tenders may be submitted for any or all of the schedules, Nos. 1, 2, and 3a (or alternatively 3b).

The Docks Committee of the Council of the City and County of Bristol reserve the right to select for acceptance any schedule from any Tender and to reject the others, and they do not bind themselves to accept the lowest or any Tender.

W. W. SQUIRE,
Engineer.
Engineer's Office,
Cumberland Basin, Bristol,
24th June, 1907. 1139

## Bristol Docks. — Avonmouth Dock Works.

ELECTRIC TWO-TON CAPSTANS.

The Docks Committee of the Council of the City and County of Bristol are prepared to receive TENDERS for the CONSTRUCTION, DELIVERY, ERECTING in PLACE, FITTING, TESTING, and MAINTENANCE for 12 twelve months after completion, of 10 ELECTRIC 2-TON WAGON CAPSTANS, to be erected at the Royal Edward Dock now in course of construction at Avonmouth, in the Port of Bristol.

Tenders will be considered only from firms who have done similar work before, and tenderers will be required to state what work they have done of a similar nature.

On and after Monday, July 1st, 1907, copies of the specification, form of Tender, form of contract, and copies of the contract drawings can be obtained from the undersigned on production of a receipt from the secretary of the Docks Committee showing that £3 has been paid as deposit. The deposit of £3 will be returned to bona fide tenderers after receipt of a Tender accompanied by all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope and endorsed "Tender for Electric Capstans," and addressed to the Secretary of the Docks Committee, Dock Offices, 19, Queen-square, Bristol, and must be delivered to him, accompanied by the prescribed documents, before 10 a.m. on Friday, the 26th July, 1907.

The Docks Committee of the Council of the City and County of Bristol do not bind themselves to accept the lowest or any Tender.

W. W. SQUIRE,
Engineer.
Engineer's Office,
Cumberland Basin, Bristol,
24th June, 1907. 1140

## Bombay, Baroda, and Central India Railway Company.

The Directors are prepared to receive, up to noon on Tuesday, 9th July, TENDERS for the SUPPLY of the following STORES, viz.:—

1. GIRDER BRIDGES.
2. PAINTS, &c.
3. SPRING STEEL.
4. MANILLA LASHING ROPES.
5. METALS.
6. WOOD SCREWS.

Tenders must be made on forms, copies of which, with specifications, can be obtained at these Offices on payment of 21s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

W. V. CONSTABLE,
Secretary.
Offices, Gloucester House,
2, 3, and 4, Bishopsgate-street Without,
London, E.C.
27th June, 1907. 1200

## City of Norwich.—Sewage Pumping and Sewage Treatment Works.

TENDERS are invited for the following WORKS:—

CONTRACT A.—FOUR TURBINE PUMPS.
CONTRACT B.—about 2½ MILES of 33in. REINFORCED CONCRETE RISING MAIN on the "Bonna" system.

Actual makers of the above are requested to apply to me for forms of Tender and to be shown the drawings and specifications.

Tenders on the forms supplied, enclosed in envelopes sealed with sealing wax, endorsed "Contract A" or "Contract B," as the case may be, and addressed to the Chairman of the Sewerage Committee, must be delivered at my office not later than 10 a.m. on Tuesday, 9th July, 1907.

The Corporation does not bind itself to accept the lowest or any Tender.

ARTHUR E. COLLINS, M. Inst. C.E.,
City Engineer, &c.
Guildhall, Norwich,
19th June, 1907. 1125

## Corporation of Calcutta.—

TENDERS are invited, and will be received by the Vice-Chairman up to 3 p.m., 2nd January, 1908, for the LIGHTING by Gas, Oil, Electricity, or other illuminant of the STREETS, THOROUGHFARES, and PUBLIC RESORTS of the City of Calcutta as vested in the Corporation of Calcutta.

The City comprises approximately an area of 20 square miles, containing about 170 miles of main thoroughfares and 150 miles of smaller streets and lanes, besides several squares, markets, latrines, slaughter-houses, and other public resorts, the whole being lighted at present by 9225 gas lamps of 24 c.p., 84 higher power lamps equivalent to 2074 lamps of 24 c.p., and 2400 oil lamps.

The new contract is timed to commence on the 1st May, 1911, and the successful Tenderer or Tenderers will be required to have all arrangements completed and ready to begin and continue the lighting with effect from that date.

Tenders should be for 10, 15, or 20 years.

It is left to Tenderers to propose their own plans for carrying out the project, the end in view being to considerably improve the present lighting of the city, and to this end it is suggested that representatives should be deputed to personally inspect the area to be lighted and the system now in force, in order that they may be in a position to judge for themselves as to the best means to be adopted for attaining the desired object.

The Corporation do not bind themselves to accept the lowest or any Tender.

P. N. MOOKERJEE,
Secretary to the Corporation.
Municipal Office,
Dated the 2nd May, 1907. 755

## County Borough of Warrington.

ELECTRICITY DEPARTMENT.

The Electricity and Tramways Committee of the County Borough of Warrington are prepared to receive TENDERS for the ERECTION of BUILDINGS for Boiler Plant Extension.

Bills of quantities and forms of Tender may be obtained from the undersigned, and drawings may be seen at the Office, Howley, Warrington, on payment of One Guinea, which will be returned on receipt of a bona fide Tender.

Five shillings will be charged for extra copies.

Tenders, addressed to the Chairman of the Electricity and Tramways Committee, Town Hall, Warrington, must be sealed with wax, and endorsed "Tender for Buildings," and delivered not later than 12 o'clock noon on Tuesday, 16th July, 1907.

The lowest or any Tender will not necessarily be accepted.

F. V. L. MATHIAS,
Borough Electrical and Tramways Engineer.
Howley, Warrington. 1129

## County of London.—The London

County Council invites TENDERS for the MANUFACTURE of SUNDRY OIL TANKS, FILTERS, &c., to be delivered at the Council's generating station at East Greenwich.

Full particulars and also information as to the conditions to be observed by tenderers will be given in the "London County Council Gazette" of 1st July, 1907.

The Gazette, which is published weekly, contains particulars of all the Tenders invited by the Council, and can be obtained from Messrs. P. S. King and Sons, 2 and 4, Great Smith-street, Westminster, S.W., price 1d., post free 1½d., an issue, or for the whole year a prepaid subscription of 6s. 6d.

Tenders must be upon the official forms to be obtained from the Clerk of the Council, County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of a sum of £2 for the specification, drawings, &c., and no Tender will be received after 11 a.m. on Tuesday, 16th July, 1907.

The Council does not bind itself to accept the lowest or any Tender, and it will not accept the Tender of any person or firm who shall on any previous occasion have withdrawn a Tender after the same had been opened unless the reasons for the withdrawal were satisfactory to the Council.

G. L. GOMME,
Clerk of the London County Council.
County Hall,
Spring-gardens, S.W.,
25th June, 1907. 1186

## Great Western Railway.—The

Directors of this Company are prepared to receive TENDERS for the RECONSTRUCTION of RANELAGH BRIDGE which carries a public road over the Great Western Railway near Paddington station.

Plans and Specification may be seen, and forms of Tender and Bills of Quantities obtained at the Office of the Engineer at this Station, between the hours of 10 a.m. and 4 p.m.

Tenders addressed to the undersigned, and marked outside "Tender for Ranelagh Bridge, Paddington," will be received on or before Tuesday, the 16th July.

The Directors do not bind themselves to accept the lowest or any Tender.

G. K. MILLS,
Secretary.
Paddington Station, London,
19th June, 1907. 1154

TO ENGINEERS AND OTHERS.

## The Metropolitan Asylums Board

invite TENDERS for NEW BOILER INSTALLATION and MACHINERY at the North-Eastern Hospital, Tottenham, in accordance with drawings and specification prepared by Mr. W. T. Hatch, M. Inst. C.E., M.I. Mech. E., Engineer-in-Chief.

Drawings, specification, conditions of contract, and form of Tender may be inspected at the office of the Board, Embankment, London, E.C., on and after Monday, 1st July, 1907, and can then be obtained upon payment of a deposit of £5.

The amount of the deposit will be returned only to persons who have sent in bona fide Tenders and returned the drawings and specification in accordance with the regulations.

No Tenders will be entertained except those from thoroughly reliable firms who have executed works of equal magnitude and of the same description.

Tenders, addressed as noted on the forms, must be delivered at the Office of the Board not later than 10 a.m. on Tuesday, 23rd July, 1907.

By order,
T. DUNCOMBE MANN,
Clerk to the Board.
24th June, 1907. 1153

## Metropolitan Water Board.—

TENDERS FOR 4 HIGH-CLASS TRIPLE-EXPANSION MARINE TYPE STEAM ENGINES, 7 CENTRIFUGAL PUMPS, 3 HYDRAULIC TURBINES, &c.

The Metropolitan Water Board invite TENDERS for the PROVISION of 4 High-class Triple-expansion Marine Type Steam Engines, 7 Centrifugal Pumps, 3 Hydraulic Turbines, Sluice Valves, Steel Mains and Cast Iron Branch Pipes, 2-25 K.W. Electric Generators, 10 Water-tube Boilers, Mechanical Stokers, 2 Economisers, Steam Pipes, Feed Pumps, Coal Conveyor, Ash Hoist, Motors, &c. &c., to be erected at the new Pumping Station at Walton-on-Thames.

Forms of Tender and Contract, with a preliminary specification, may be obtained and drawings inspected on application to the Engineer of the Southern District, Southwark Bridge-road, S.E., on production of an official receipt for the sum of £10, which sum must be first deposited with the Comptroller at the Board's Central Offices, Savoy-court, Strand, W.C., and which will be returned upon receipt of a bona fide Tender.

Such payments and applications must be made between the hours of ten and four (except on Thursdays and Saturdays) on and after Monday, 1st July, 1907.

Tenders, enclosed in sealed envelopes addressed to the Clerk, Metropolitan Water Board, Savoy-court, Strand, W.C., and endorsed "Tenders for Engines at Walton," must be delivered at the offices of the Board not later than 10 a.m. on Wednesday, 24th July, 1907.

Tenders for a portion only of the above work will not be considered.

The Board do not bind themselves to accept the lowest or any Tender.

Offices of the Board, Savoy-court, Strand, W.C.
26th June, 1907. 1149

PUBLIC HEALTH ACT, 1875.

## Rural District of Bradfield, in

THE COUNTY OF BERKS.
CONTRIBUTORY PARISH OF STRATFIELD MORTIMER.

TO CONTRACTORS FOR WELL BORING.

The Rural District Council of Bradfield are prepared to receive TENDERS for the CONSTRUCTION of a 15in. TUBED BORING, in the Parish of Stratfield Mortimer, near Reading. The depth of such boring will be 250ft., more or less.

Further particulars and forms of Tender may be obtained, and plans may be seen at the offices of Mr. H. Howard Humphreys (the Consulting Engineer to the Council), 28, Victoria-street, Westminster, between the hours of 10 a.m. and 4 p.m. on Monday and Tuesday, the 1st and 2nd July next.

Intending contractors will be required to deposit with the Engineer a sum of Two Guineas prior to their being furnished with particulars of the [illegible] and such sum will be returned upon receipt of a bona fide tender.

Tenders, endorsed "Tender for Borehole, Stratfield Mortimer," must be delivered to me, in order to reach me, the undersigned, not later than [illegible] Wednesday, 9th day of July, 1907.

The Council do not bind themselves to accept the lowest or any Tender.

[illegible] this 24th of June, 1907.

R. E. RAWSTORNE,
Clerk to the Council.
[illegible]sham,
1131

BUOYS AND GAS RECEIVERS.
Trinity House, London, E.C.
27th June, 1907.

## [illegible]ers are Hereby Invited for

the CONSTRUCTION and DELIVERY, as required, of [illegible]EVEN Riveted or Welded STEEL GAS BUOYS and THREE GAS RECEIVERS.

Drawings may be inspected and forms of Tender obtained at this House, between the hours of 10 a.m. and 5 p.m.

Tenders, marked outside "Tender for Gas buoys," must be addressed to the secretary, and delivered at this House on or before Thursday, the 11th July, and no Tender can be entertained that is not made on the form provided.

The Corporation does not pledge itself to accept the lowest or any Tender.

A. OWEN,
Secretary.
1118

## The Bengal and North-Western Railway Company.

The Directors are prepared to receive TENDERS for the SUPPLY and DELIVERY of:—

(a) [illegible] DOZEN FILES.
(b) 35 TONS COPPER and 10 TONS TIN INGOTS.
(c) 100 TONS RED and 50 TONS WHITE LEAD (Dry Powder),

as per specifications to be seen at the Company's Offices.

Tenders, addressed to the undersigned, and marked "Tenders for Files," or as the case may be, are to be lodged not later than noon on Monday, the 8th day of July, 1907.

For each specification a fee of 10s. will be charged, which cannot, under any circumstances, be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
ALEXANDER IZAT,
Managing Director.
237, Gresham House,
Old Broad-street, London, E.C.,
27th June, 1907. 1198

## The South Indian Railway Company,

LIMITED, is prepared to receive TENDERS for the SUPPLY of:—

(1) ROLLING STOCK:—
115 Steel Covered Goods Bogie Wagons.
30 Bogies for Carriages.
(2) WHEELS and AXLES—400 Pairs.
(3) LAMINATED BEARING SPRINGS—1100.
(4) SWITCHES and CROSSINGS—2 Sets.

Specifications and forms of Tender may be obtained at the Company's Offices.

Tenders, addressed to the Company, marked "Tender for Rolling Stock," or as the case may be, must be left with the undersigned not later than 12 o'clock noon of Tuesday, the 9th July, 1907.

The Company is not bound to accept the lowest or any Tender.

A charge which will not be returned, will be made of 20s. for each copy of Specification (1) and 10s. for each copy of Nos. 2, 3, and 4.

Copies of the drawings may be obtained at the office of Sir George B. Bruce, 3, Victoria-street, Westminster, on payment of 5s. per sheet.

By order,
J. SHAW STEWART, Major-General R.E.,
Managing Director.
Company's Offices:
55, Gracechurch-street, London,
26th June, 1907. 1199

## The Madras Railway Company

REQUIRE the SERVICES of an ASSISTANT SIGNAL INSPECTOR in India. Age about 27, preferably unmarried.

Applicants must have a thorough all-round practical knowledge of how to Erect, Maintain, and Repair Railway Signals, including Interlocking Frames, Connections, &c.

Engagement for four years. Salary Rupees 250 per month for the first two years and Rupees 300 for the second two years. Free passage to Madras.

Applications, stating age and giving brief particulars of past experience, to be sent to W. H. COLE, Secretary, 1, Broad-street-place, London, E.C., not later than 3rd July.

London, 21st June, 1907. 1155

*For Continuation of Official Advertisements see page* II.

## SMALL ADVERTISEMENTS SITUATIONS, FOR SALE &c.

*Pages* II., III., IV., LXXII.

**Numerical Index to Advertisements,** *Page* LXIX

**Subject-Matter Index to Advertisements** *Page* LXXI.

## Willesden District Council.

TO CONTRACTORS.

The Willesden District Council are prepared to receive TENDERS for the WIDENING of BRIDGE over the London and North-Western Railway in the Harrow-road, Harlesden, Willesden, N.W.

Plans may be seen, and specification and quantities obtained, together with all other particulars, upon payment of Two Guineas, which will be returned to the Contractor upon the receipt of a bonâ fide Tender, on and after Monday next, June 24th, 1907, upon application to Mr. O. Claude Robson, M. Inst. C.E., Engineer to the Council, Public Offices, Dyne-road, Kilburn, N.W.

Tenders, ended and "Tender for Harrow-road Bridge," with accompanying priced quantities, to be delivered at the offices of the Council not later than 4 p.m. on Tuesday, July 2nd, 1907.

A £10 note to be deposited with each Tender, which will be returned to all unsuccessful contractors immediately Tenders are accepted, and to the successful contractor after execution of contract and bond.

The Council do not bind themselves to accept the lowest or any Tender.

By order,
STANLEY W. BALL,
Clerk to the Council.

Public Offices:
Dyne-road, Kilburn, N.W.,
June 19th, 1907. 1078

## Egyptian Government.—Ministry

OF PUBLIC WORKS, CAIRO.
SERVICE D'ASSAINISSEMENT DE LA VILLE DU CAIRE.

WANTED, from the First of January, 1908, a fully qualified MECHANICAL ENGINEER having a thorough knowledge of the design of Sewage Pumps and Compressed Air Machinery. Preference will be given to a member of the Institution of Mechanical Engineers and one having a good knowledge of French. Should be unmarried, and age not to exceed 36 years.

The successful candidate will be required to submit himself to a medical examination before joining.

In the case of approved service, the duration of the appointment is two years, with possible extension for the supervision of the carrying out of the works.

The salary will be from £E 400 to £E 500 per annum, according to qualifications. A sum of £E 30 will be allowed for passage money from England.

The selected applicant will be subject to all the rules and regulations of the Egyptian Government.

Applications, with testimonials and complete statement of previous service, should be sent to the PRIVATE SECRETARY to the Controleur Général des Travaux d'Assainissement de la Ville du Caire, Ministère des Travaux Publics, c.o. Private Secretary to Director of the Imperial Institute, London, S.W., not later than 25th July, 1907. 1133

## Port of Sunderland. Appointment of Resident Engineer.

The River Wear Commissioners are prepared to receive APPLICATIONS for the POSITION of RESIDENT ENGINEER for their Harbour and Dock Works, in connection with which Mr. Henry H. Wake, M. Inst. C.E., is their Consulting Engineer.

The salary will commence at £400 per annum.

Applicants must be duly qualified civil engineers, not more than 40 years of age, and must have had experience in the construction and maintenance of Harbour and Dock Works.

The gentleman appointed will not be allowed to carry on private practice, and he will be required to devote the whole of his time to the duties of his office and to reside within the borough.

Applications, stating age, qualifications and experience, and accompanied by copies (which will not be returned) of not less than three nor more than four testimonials of recent date, and endorsed "Resident Engineer," [illegible] to be delivered to the undersigned not later than the 27th [illegible] next.

The canvassing of Commissioners, either directly or indirectly, will be deemed a disqualification.

By order,
J. G. [illegible]
Clerk [illegible] missioners.

Clerk's Office, Sunderland,
26th June, 1907. 1173

## Wanted, a Practi[illegible]ry

MANAGER to Take Charge [illegible]
Must have first-class experience in th[illegible]
Iron Pipes, Specials, and General Ca[illegible]
working. State age, experience, and s[illegible]
applications treated strictly confidential.—[illegible]
Wheeler's advertising Office, Manchester.

## Wanted, Manager, to R[illegible]

Charge of large Smelting Wo ks employing about [illegible] men. Must have up-to-date knowledge of Smelting of Copper, Lead, Silver, and Gold Ores.—Address, giving age, particulars of experience, and salary required, 1047, Engineer Office, 33, Norfolk-street, Strand, W.C. 1047

## Works Manager.—Wanted for

India, a Practical MECHANICAL ENGINEER, with good knowledge of steel structural work, for large works having fitting and turning shops, smithy, foundry, and steel structural department. Must be energetic, and thoroughly competent to take charge; age 28 to 34 years. Applications, giving full particulars of experience, age, &c., will be treated confidentially.—Address, P12, Engineer Office, 33, Norfolk-street, Strand, W.C. P12

## Applications are Invited for the

POST of JUNIOR INSPECTING ENGINEER, in the service of the
COLONIAL SUGAR REFINING COMPANY, LIMITED, OF SYDNEY.

Particulars as to salary, duties, &c., can be obtained from:
Messrs. PARBURY, HENTY and CO., 29, Eastcheap, London; or
Mr. J. RICKERING, Baltic-chambers, 50, Wellington-street, Glasgow,
to whom the applications are to be forwarded on or before the 3rd July, 1907. 946

## Appointments.—Permanent

LOCAL GOVERNMENT APPOINTMENTS as Inspectors of Weights and Measures may be obtained by men over 21 who are prepared to pass the Board of Trade exam.; salaries £100 to £300 a year; numerous successes.—Write for particulars to INSPECTOR of WEIGHTS and MEASURES, Oakham, Rutland. 567

## Assistant Manager Required for

a Railway in Spain; must have had experience of railway organisation, working, and accounts; good knowledge of Spanish indispensable.—Applications, stating salary, with copies of testimonials, to be addressed, before the 15th July, to SPAIN, care of Streets, 30, Cornhill, E.C. 1164

## Engineer-in-Charge Wanted,

accustomed to running Engines and Boilers. Marine experience desirable.—Address with copies of testimonials and stating salary required, H. DAWSON, Electric Lighting Department, 1, Whitehall-road, Leeds. 1134

## Railway Manager Required for

South America; must have experience in similar capacity and speak Spanish. State full particulars of previous experience, age, and salary required.—E. W., care of J. W. Vickers and Co., 5, Nicholas-lane, E.C. 1130

## Shipbuilding and Engineering.

—LONDON MANAGER WANTED.—A leading Continental shipbuilding and Engineering Firm, with a fair connection in the United Kingdom, intending to open London Offices, SEEKS a MANAGER for these Offices. With a view to the firm's specialities, preference will be given to applicants who are well introduced amongst harbour authorities and contractors, and have good connections in different parts of the British empire.—Address applications, with full particulars, to 1135, Engineer Office, 33, Norfolk-street, Strand, W.C. 1135

## Superintendent for Engineering

Department of Cement Works WANTED. Must be qualified engineer, accustomed to large works and charge of men. Age limit forty.—Apply by letter, stating age, experience, and salary required, to P42, Engineer Office, 33, Norfolk-street, Strand, W.C. P42

## Tool Works Manager.—Adver-

TISER WISHES to MEET with a thoroughly experienced MAN capable of UNDERTAKING the MANAGEMENT of TOOL WORKS. Must have a perfect know edge of the manufacture of milling cutters, reamers, &c., from the blank to the finished article.—address, 1191, Engineer Office, 33, Norfolk-street, Strand, W.C. 1191

## Wanted, First-class All-round

DRAUGHTSMAN for General Engineering, experienced in Electricity, Colliery, and Ironworks Plant; state age, experience, and salary required.—THOMAS JOHNSON, Prescott-street, Wigan. 1176

## Wanted, First-class Draughts-

MAN, a[illegible]st be well experienced in Iron and Steel Works Plant. Good salary will be paid to suitable man.—Apply, stating age, experience, and salary required, to LILLE[illegible] HALL CO., Ltd., Engineers, Oakengates, Shropsh[illegible]

## A Reliable Mechanical Draughts-

MAN WANTED on South Coast, with experience in Petrol Engines, to make a few detailed Alterations in a Set of Drawings; a week-end job.—Address, P54, Engineer Office, 33, Norfolk-street, Strand, W.C. P54

## Competent Draughtsman Wanted

with experience in Engine Design and Pipe arrangements, also good technical training and some electrical knowledge.—Address, stating age, experience, and salary required, P38, Engineer Office, 33, Norfolk-street, Strand, W.C. P38

## Draughtsman, Agricultural Im-

PLEMENTS.—WANTED, an experienced DRAUGHTSMAN for the Cattle Food Preparing Machine Trade, also for designing Tools, Jigs, &c., for repetition work for same.—Address, stating age, experience, and salary required, to 1051, Engineer Office, 33, Norfolk-street, Strand, W.C. 1 61

## Draughtsman (First-rate) Re-

QUIRED for works in Midlands, experienced in General Structural Steelwork Design and Gas Works Plant. Must be quick and accurate with shop drawings, and able to work out own details and stresses. None but thoroughly reliable men need apply. State age, giving references and salary required, with full particulars of experience, and when could commence.—Address, 1166, Engineer Office, 33, Norfolk-street, Strand, W.C. 1166

## Draughtsman Wanted, with

previous experience of Steel Rolling Mills preferred.—Apply T., 13, Ashville-road, Birkenhead. 1127

## Locomotive Draughtsman.—Ex-

PERIENCED MAN WANTED at once.—Apply, KERR, STUART and CO., Ltd., Engineers, Stoke-on-Trent. 1124

## Wanted, First-class Up-to-date

FOREMAN for Lancashire Type Boiler Works; non-society preferred; 6 o'clock; state wages, &c.—Address, P986, Engineer Office, 33, Norfolk-street, Strand, W.C. P986

## Wanted, Foundry Foreman,

accustomed to general Engine and Gas Engine Castings, able to Estimate, and Take full Control of Men.—Address, stating previous experience and wages required, 1143, Engineer Office, 33, Norfolk-street, Strand, W.C. 1143

## Capable Non-Union Foreman for

Lancashire. Must be total abstainer; well up in latest methods; good controller; 6 o'clock man. Only first-class men need reply, giving particulars of experience, age, salary required, when disengaged, qualification, reference.—Reply fully, I 67, Engineer Office, 33, Norfolk-street, Strand, W.C. 1167

## Foreman Engineer with Experi-

ENCE in small Launch Machinery, a knowledge of Electric Light Installation and Repairs for Shop, and capable of Estimating Cost of General Repairs to Tug and Coasters Machinery.—Reply, stating age, experience, and wages required, to 1180, Engineer Office, 33, Norfolk-street, Strand, W.C. 1180

## Foreman.—Wanted, in the Fitting

Shops of a large Works, making general castings, pipes, and structural work, a skilled FOREMAN, possessing practical knowledge and accustomed to the management of men; must be well up in modern methods of working and piecework prices. Applicants must state age, salary required, and give full details of previous experience.
Address, P43, Engineer Office, 33, Norfolk-street, Strand, W.C. P43

## Patternmakers.—Working Fore-

MAN, with an all-round experience upon engineers' work. Applicants must state fully past employers and length of service. Permanency. Midlands.—Address, 1144, Engineer Office, 33, Norfolk-street, Strand, W.C. 1144

## Smart Agents Wanted for Sale

of Case-hardening Compound in great demand; good commission terms and allowance to suitable men.—Letters only, DURVITE, 15, Victoria-street, S.W. P70

## Wanted, Energetic Traveller,

small salary and commission, used to Selling Boilers [illegible]achinery.—Apply, by letter, stating experience, &c., [illegible]2, Messrs Deacon's, 154, Leadenhall street, E.C. 1156

## Gas Engine Traveller (Junior)

REQUIRED to Work London District. State age, salary, and experience.—Applications treated in confidence to P32, Engineer Office, 33, Norfolk-street, Strand, W.C. P32

## Wanted, a Junior Cost Clerk,

for an Engineering Works in London; some knowledge of the card system preferred.—Address, P44, Engineer Office, 33, Norfolk-street, Strand, W.C. P44

## Wanted Immediately, Good

FITTER-DRIVER used to engine driving and stoking; wages 30s.; only experienced men need apply.—Applications, with reference, to MANAGER, Frimley and Farnborough District Water Works, Farnborough, Hants. 1158

## Cutter Grinder.—A First class

CUTTER REQUIRED, one accustomed to the Grinding of Milling Cutters, Reamers, &c.—Address, 1193, Engineer Office, 33, Norfolk-street, Strand, W.C. 1193

## First-rate Tool Expert to Keep

Tools in Order. Improve them and their Work, Suggest Piecework Prices and Increase Production; must have experience in new English and American tools, jigs and other appliances. Give reference, age, salary required, full experience, when disengaged; non-union preferred.—Address, 1168, Engineer Office, 33, Norfolk-street, Strand, W.C. 1168

## Tool Hardener.—Wanted, Expe-

RIENCED HARDENER of TOOLS, with good knowledge of High-speed Steel Hardening.—Address, 1192, Engineer Office, 33, Norfolk-street, Strand, W.C. 1192

## A M.I.C.E., at Present Manager

of Constructional Steelworks, DESIRES CHANGE in similar capacity, or with railway or consulting engineers.—Address, P79, Engineer Office, 33, Norfolk-street, Strand, W.C. P79

## Civil Engineer, 17 Years' Experi-

ENCE, largely waterworks, sewerage, and bridge-building, home and abroad, WANTS ENGAGEMENT; London preferred; excellent references; would take temporary work.—Address, P73, Engineer Office, 33, Norfolk-street, Strand, W.C. P73

## Contractor's Engineer and Clerk

OF WORKS, now completing large colliery contract, DESIRES SIMILAR POST. Experienced in colliery, coke oven, steel structures, and steam plant.
Address, 1202, Engineer Office, 33, Norfolk-street, Strand, W.C. 1202

## Engineer, A.M.I.C.E. (37), 15

years' experience in Waterworks undertakings as Assistant and Resident Engineer, is OPEN to ACCEPT SIMILAR WORK.—Address, P839, Engineer Office, 33, Norfolk-street, Strand, W.C. P839

## Engineer, Assoc. M. Inst. C.E.,

12 years' experience as Assistant and Resident Engineer in Waterworks Construction and Management at Home and Abroad, DESIRES RE-ENGAGEMENT.—Address, P57, Engineer Office 33 Norfolk-street, Strand, W.C. P57

## Engineer, Manchester, Desires

ENGAGEMENT as ASSISTANT MANAGER or REPRESENTATIVE; good connection in Lancashire shop, D.O., and 6 years' commercial experience.—Address, P65, Engineer Office, 33, Norfolk-street, Strand, W.C. P65

## Engineer (26), 1st Class B.O.T.

Certificate, shop and drawing-office, five years' sea experience, excellent references, REQUIRES POSITION ASHORE.—I. R. DAVIES, 71, Ham Park-road, Stratford, E. P53

## Engineer (28) Desires Post as

ASSISTANT WORKS MANAGER or DRAUGHTSMAN. Moderate salary for progressive engagement; good all-round experience D.O. and workshops; accustomed to control men; excellent references.—Address, P9, Engineer Office, 33, Norfolk-street, Strand, W.C. P9

## Engineer (30) Requires Situation

as General Manager's Assistant, Works or Commercial Manager in Engineering Works; workshops, drawing-office, counting-house, and general management experience; good estimator.—Address, P857, Engineer Office, 33, Norfolk-street, Strand, W.C. P857

## Engineer (33), First B.T. Cert.,

two years chief Australasian liner, five years shop and drawing-office, twelve years sea experience, REQUIRES BERTH ashore. Excellent testimonials.—Address, P917, Engineer Office, 33, Norfolk-street, Strand, W.C. P917

## General Manager.—To Structural

STEELWORK, BRIDGE, TANK, AND GIRDER MANUFACTURERS.—A gentleman (52), of exceptional energy and business experience, DESIRES POSITION of GENERAL MANAGER in a business requiring reorganisation on modern and up-to-date methods of manufacture. Has thoroughly competent civil and mechanical engineer of 18 years' practical experience in reconstruction of works, organisation and control of staff and drawing-office, and handling large bodies of men; is accustomed to negotiate large Government, railway, and municipal contracts; expert in estimating, and well up in up-to-date methods of accounting and cost-keeping.—Address, P45, Engineer Office, 33, Norfolk-street, Strand, W.C. P45

## Gentleman, Young, Successful

record, thoroughly conversant with steel and iron[illegible] dry practice, sound commercial experience, good connection amongst leading buyers, executive ability and accustomed to take initiative, capable organiser, DESIRES CHANGE. Sole management, re-organisation, introducing latest and up-to-date methods.—Address, STEEL, Wm. Porteous and Co., Glasgow. P912

## Gentleman (28) Desires Position

ASHORE; 4 years in fastest Atlantic ships; at present with Premier Steamship Company; apprenticeship with notable inland firm; D.O. and patternshop; 1st R.O.T. Certificate.—Address, P26, Engineer Office, 33, Norfolk-street, Strand, W.C. P26

## Gentleman (30) First-class Engi-

NEER'S B. of T. certificate, 8 years' shop, 7 years' seagoing, DESIRES a CHANGE, home or abroad.—Address, P50, Engineer Office, 33, Norfolk-street, Strand, W.C. P50

## German Engineer (25) Seeks

SITUATION; experienced in construction of new plants, flour mills; first-class draughtsman; fair knowledge of English.—Address, 122, Roman-road, London, N. P47

## Manager of Engineering Works

(39) DESIRES CHANGE, 24 years' practical and commercial experience; up to date, keen, strong, determined, and tactful; highest references.—Address, P55, Engineer Office, 33, Norfolk-street, Strand, W.C. P56

## Mechanical Engineer, Graduate

of German College, 3 years' experience (2 in United States), DESIRES POSITION as DESIGNER; salary not under £4 weekly.—Address, P25, Engineer Office, 33, Norfolk-street, Strand, W.C. P2

## Mechanical Engineer, M.I.M.E.,

OPEN to ENGAGEMENT; wide experience, hard worker, best references, moderate terms if London district.—Address, P46, Engineer Office, 33, Norfolk-street, Strand, W.C. P46

## Mechanical Engineer (42), with

shop and D.O. experience in engine and marine work, DESIRES POSITION; good refs; Stud. Inst. C.E.—Address, P68, Engineer Office, 33, Norfolk-street, Strand, W.C. P68

## Mech. Engineer (35), with 18

yrs. experience in design and construction of machines, steam and pumping engines, also general engineering and factory management, DESIRES POST as MANAGER, ASSISTANT, or any Position of Trust.—Address, P1, Engineer Office, 33, Norfolk-street, Strand, W.C. P1

## Practical Mechanical Engineer

(30), energetic and competent to take charge, SHORTLY DISENGAGED. Excellent references from well-known firms.—Address, P36, Engineer Office, 33, Norfolk-street, Strand, W.C. P36

## Surveyor and C.E., Age 30,

REQUIRES POST on Large Works, setting-out and supervision of excavations, foundations, buildings, constructional steelwork, railroads.—Write SURVEYOR, 10, Howitt-street Hyson Green, Nottingham. P65

## Stores Manager or Assistant,

fifteen years' commercial experience, good technical knowledge of engineers' requisites, prime cost, accounts, &c., up-to-date methods; aged 35; moderate salary.—Address, P39, Engineer Office, 33, Norfolk-street Strand, W.C. P39

## Young Gentleman, Just Com-

PLETED 5 years' pupilage, shops and D.O., civil engineering, public school education, DESIRES POSITION as ASSISTANT ENGINEER, home or abroad; had training in surveying; speaks French fluently.—Address, P40, Engineer Office, 33, Norfolk street, Strand, W.C. P40

## Portland Cement.—A Highly-

QUALIFIED Technical Chemist, with exceptional experience in the testing and manufacture of Portland cement, OFFERS his SERVICES to any gentleman or firm interested in this direction.—Address, P48, Engineer Office, 33, Norfolk-street, Strand, W.C. P48

## Draughtsman, Improver (20),

SEEKS APPOINTMENT, previous experience in motor car work, quick and neat tracer; highest reference.—Address, S. J., 41, Apsley-road, South Norwood, S.E. P51

## Jig and Tool Draughtsman (22)

REQUIRES POSITION; 3 years shops and 4 years D.O.; excellent references.—Address, E. S., 241, Brettenham-road, Walthamstow, N.E. P76

## Junior Draughtsman (21)

DESIRES APPOINTMENT; excellent testimonials; six years' practical shop and office experience.—T. J. H., 41, Queen's road, High Wycombe. P62

## Foreman or Leading Hand, 15

years' experience in light constructional, and exceptional experience in iron staircases.—G. W., 48, St. Stephen's-avenue, Shepherd's Bush, London. P70

## A Mechanical Engineer, with

wide connection and experience, DESIRES to REPRESENT in London a leading Firm of Engineers.—Address, Box 77, care of Brown's, 17, Tothill street, Westminster. P.0

## Engineer Seeks Engagement as

TRAVELLER or REPRESENTATIVE; 20 years' shop and D.O. experience, inside and out; mining and general engineering work.—ARTHUR GIBBINS, Derwent Hodge, Standishgate, Wigan. P11

## Traveller.—Gentleman, Experi-

ENCED successful Traveller, OPEN for ENGAGEMENT with good Engineering Firm or Steel Works. First-class references.—Address, P60, Engineer Office, 33, Norfolk-street, Strand W.C. P60

## Handy Man Seeks Permanency

in CHARGE of MACHINERY, used to steam and gas engines, refrigerating plant, estate work, controlling of men, accounts; steady and reliable.—Address, P61, Engineer Office, 33, Norfolk-street, Strand, W.C. P61

## Patternmaker, with Good All-

round experience in Launch Machinery. A smart workman, competent to act as foreman when required, will have PERMANENT EMPLOYMENT.—Address giving age, experience, and wages required, 1179, Engineer Office, 33, Norfolk-street, Strand, W.C. 1179

## Turner Seeks Situation, 8 Years'

experience in engine, motor, and agricultural work; steady and reliable; good reference.—Address, P39, Engineer Office, 33, Norfolk-street, Strand, W.C. P39

## Engineering Pupil.—A Firm of

Engineers in the West of England have a VACANCY for a premium PUPIL.—Address, 2001, Engineer Office, 33, Norfolk-street, Strand, W.C. 2001

## Articled Pupil.—A Large Firm

of Engineers in the Midlands, employing upwards of one thousand hands, have a VACANCY for a PREMIUM APPRENTICE.—Address, 2003, Engineer Office, 33, Norfolk-street, Strand, W.C. 2003

## Engineering Pupil.—Firm

(Government Contractors), employing 500 hands, have VACANCY; varied classes of work done, affording excellent opportunities; premium moderate.—Address, 2000, Engineer Office, 33, Norfolk-street, Strand, W.C. 2000

## Mr. James D. Roots, of Thanet

House, Temple Bar, London, has a VACANCY for a PUPIL; premium 50 guineas, returnable as salary. Some previous technical training essential. 4242

## Surveying, Levelling, &c.—

Excellent opportunity for ACQUIRING thorough practical INSTRUCTION on Extensive and Varied Surveys.—Address, P85, Engineer Office, 33, Norfolk-street, Strand, W.C. P065

## Steel Structural Expert,

A.M.I.C.E., in touch with many large British firms, own[illegible] office, WISHES WORKING ARRANGEMENTS with Foreign and Colonial Gentlemen with a view to Double-ending structural Contracts.—Confidential communications to P52, Engineer Office, 33, Norfolk street, Strand, W.C. P52

## A. M.I.C.E. and Stud. I.C.E.

EXAMS.—CORRESPONDENCE COACHING by Practical Civil Engineers. Courses for any period. Fees moderate. Only one non-success last 5 exams. Special features for foreign candidates. Send for booklet, &c.—Address, P34, Engineer Office, 33, Norfolk-street, Strand, W.C. P34

## A. M.I.C.E. by Private Tuition

or CORRESPONDENCE. Revision Courses for next Exam. Many successes.—F. B. STEWART, B.E., Tudor House, Grove-lane, Denmark Hill, S.E. P58

## Inst. C.E., and all Engineering

EXAMINATIONS.—Mr. G. P. KNOWLES, A.M.I.C.E., F.S.I., &c., PREPARES CANDIDATES Personally or by Correspondence. Many successes.—39, Victoria-street, Westminster, S.W. Tel. No. 1402 Victoria. 2010

## All Inventors Requiring Capital

should WRITE or CALL CROZIER and CO., Patent Experts, 110 and 111, Strand, London, who have many capitalists on their books who will buy good, simple inventions. No result, no charge. Advice free P46

## Required in London, Active Co-

OPERATION and FINANCIAL ASSISTANCE of ENGINEER with practical experience of a Firm making a Machine Tool specialty.—T444, Shelley's, Gracechurch-street, E.C. P71

## Young Engineer of Good Educa-

TION and sound training in shops and offices of high-class firm DESIRES POSITION of TRUST in sound concern, with view to ultimate investment if mutually satisfactory highest references.—Address, P41, Engineer Office, 33, Norfolk-street, Strand, W.C. 141

## £500 - £1000.—Electrical

ENGINEER RE-QUIRES ACTIVE INTEREST in well-established BUSINESS.—Address, P69, Engineer Office, 33, Norfolk-street, Strand, W.C. P9

## £3000 Capital Required to

Place a Motor Specialty on the Market and Extend an Established Engineering Business with valuable specialities.—Apply, Box No. 76, c.o. Browne's, 47, Tothill-street, Westminster. P29

## Wanted, a Cast Iron Tank to

hold 50,000 to 70,000 gallons; all plates must be sound and planed on the edges.—State price and where it can be seen to Box 77, G.P.O., Middlesbrough. 1128

## Wanted, a Good Second-hand

PAIR of ENGINES, simple or compound, to develop about 150 I.H.P. at a piston speed of 500 to 550ft. per minute with steam of 70 lb. pressure. Give full particulars, price, and where engine can be seen.—Address, 1182, Engineer Office, 33, Norfolk-street, Strand, W.C. 1182

## Wanted, a Second-hand Gas

ENGINE, 50 to 75 brake horse-power; must be in good condition.—Write full particulars and price, Z. F 167, Messrs. Deacon's, Leadenhall-street, E.C. 1189

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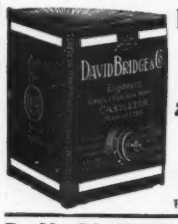


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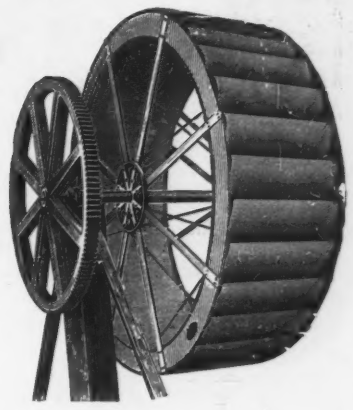

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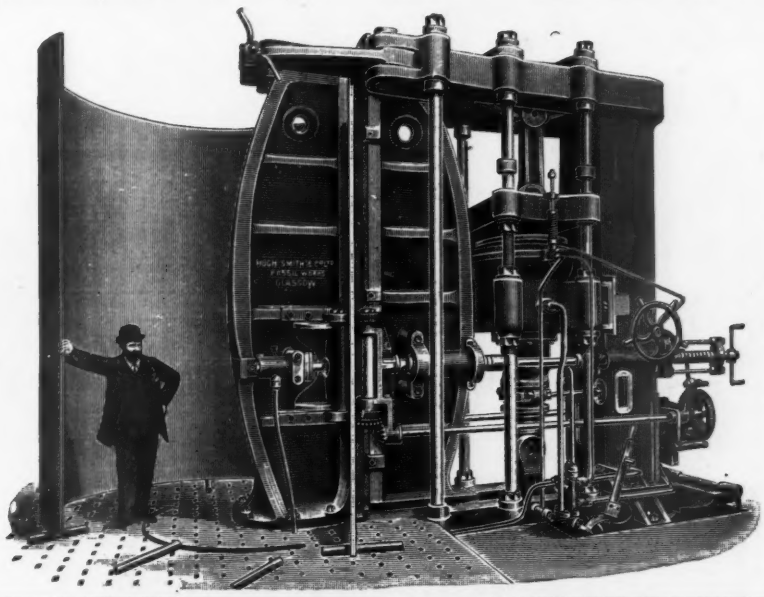

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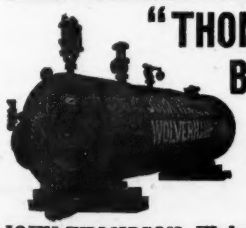

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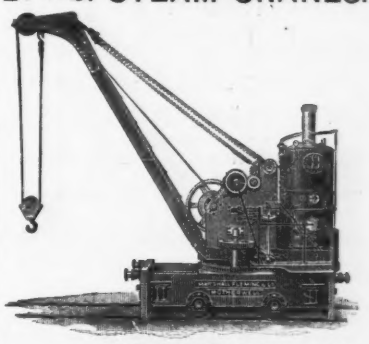

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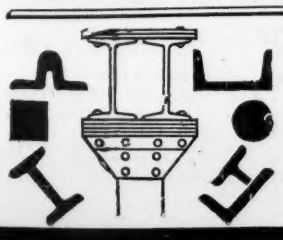

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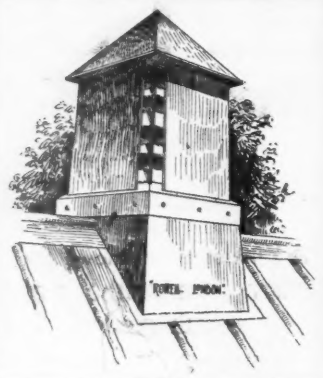

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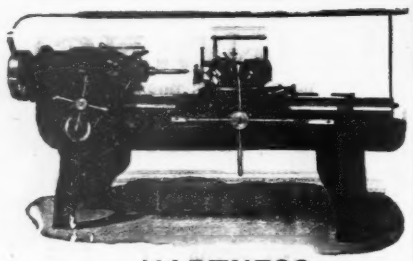

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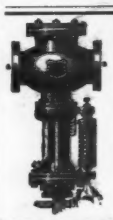

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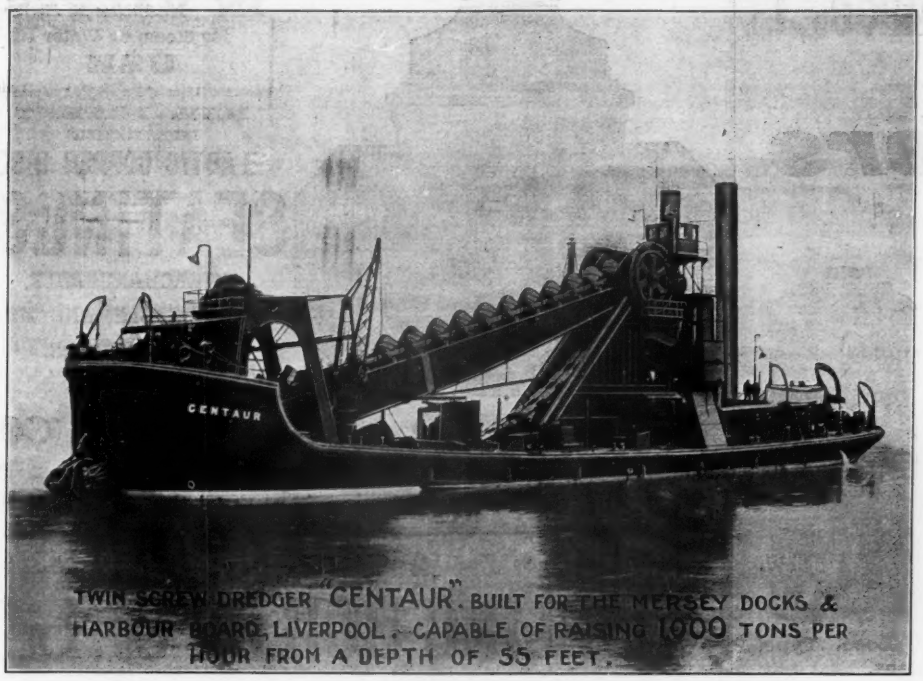


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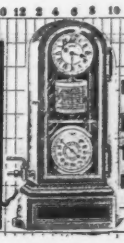

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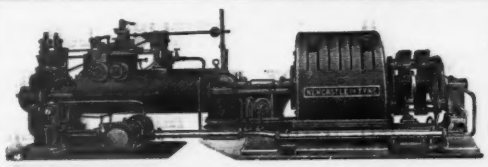

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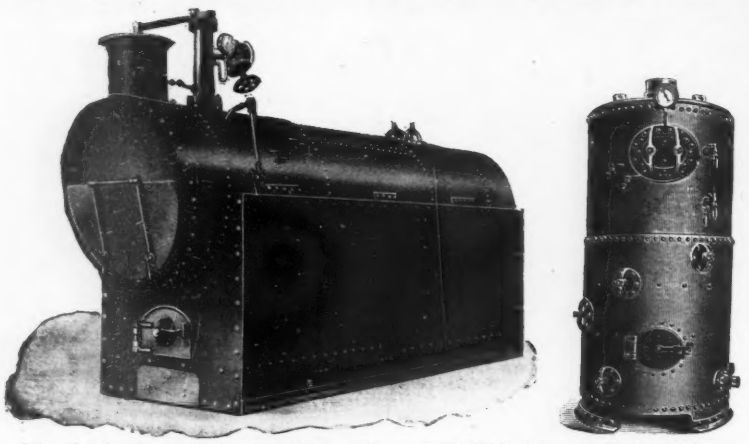

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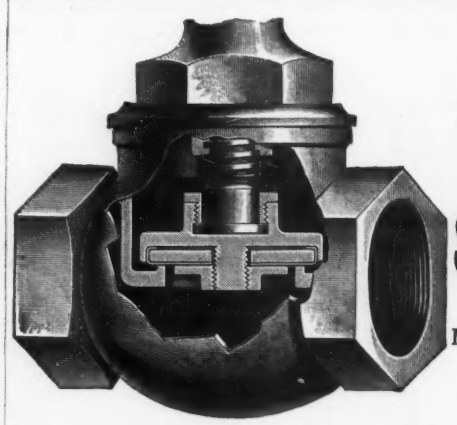

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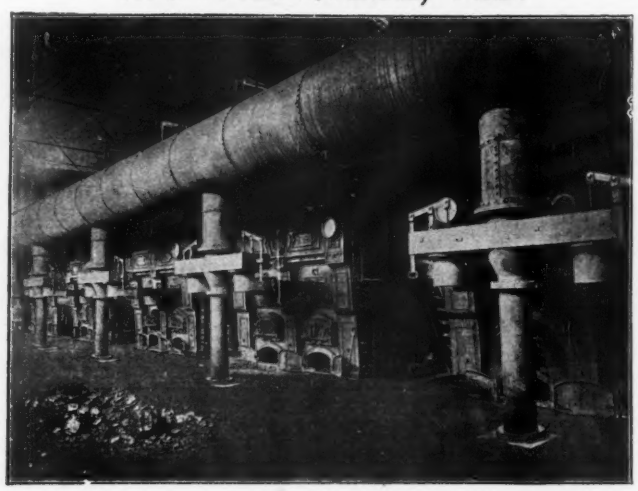

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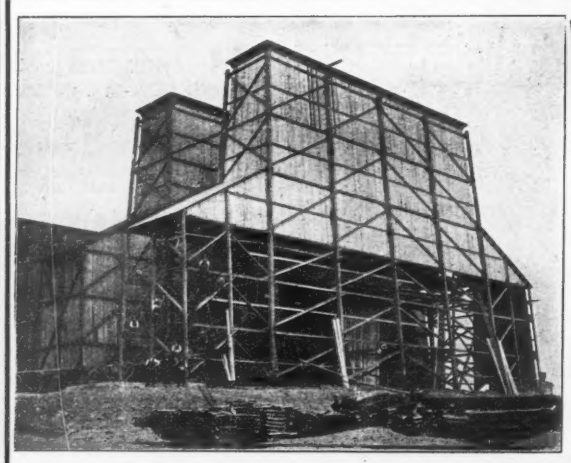

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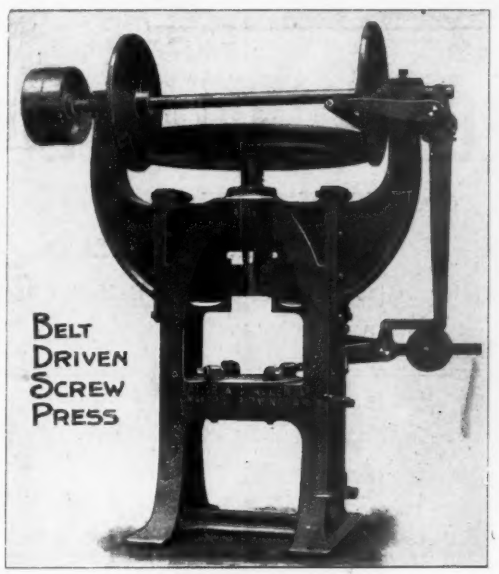


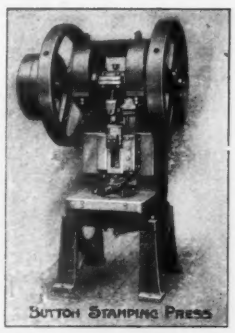


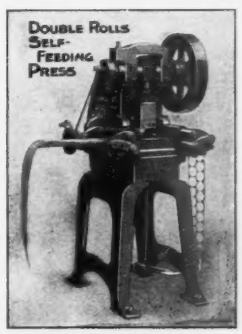


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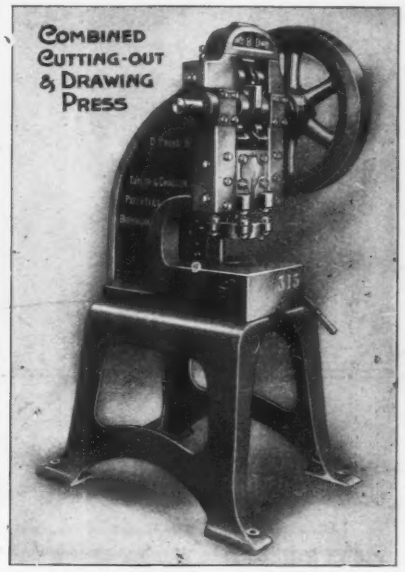


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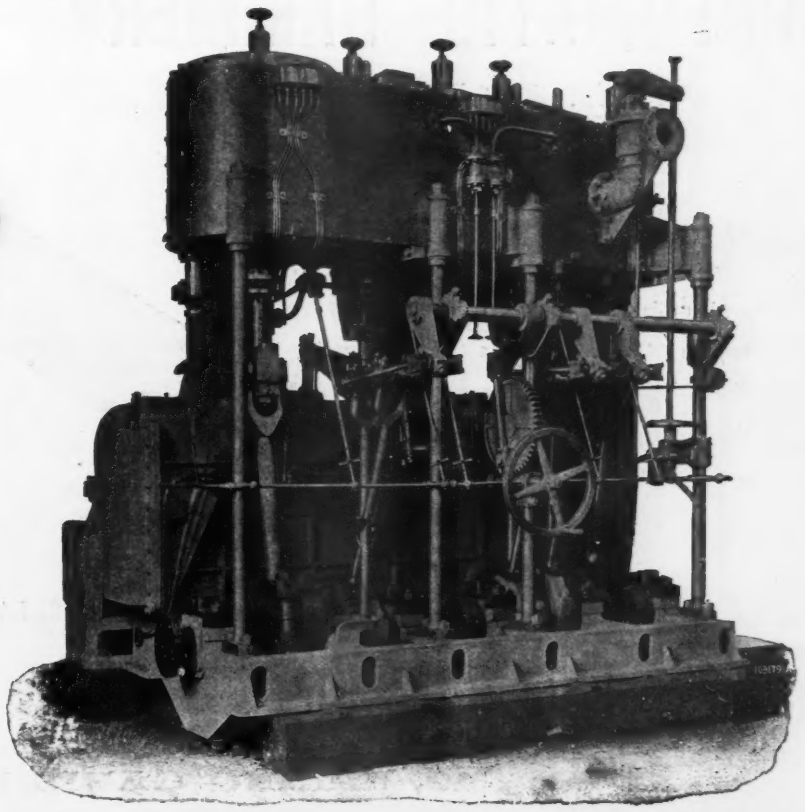

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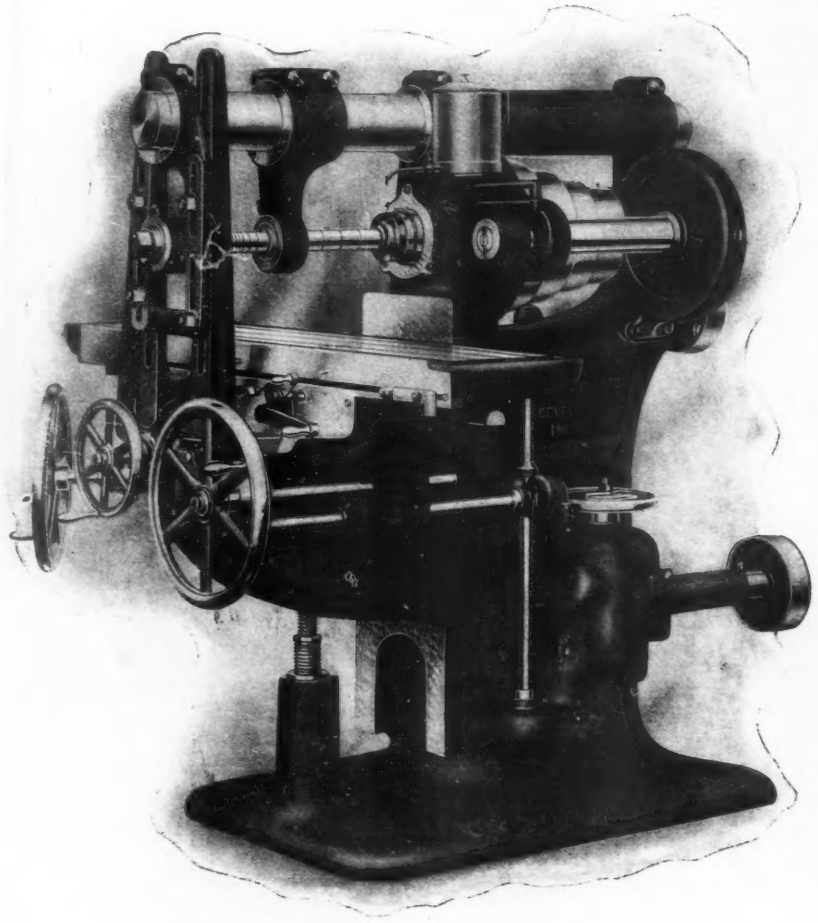

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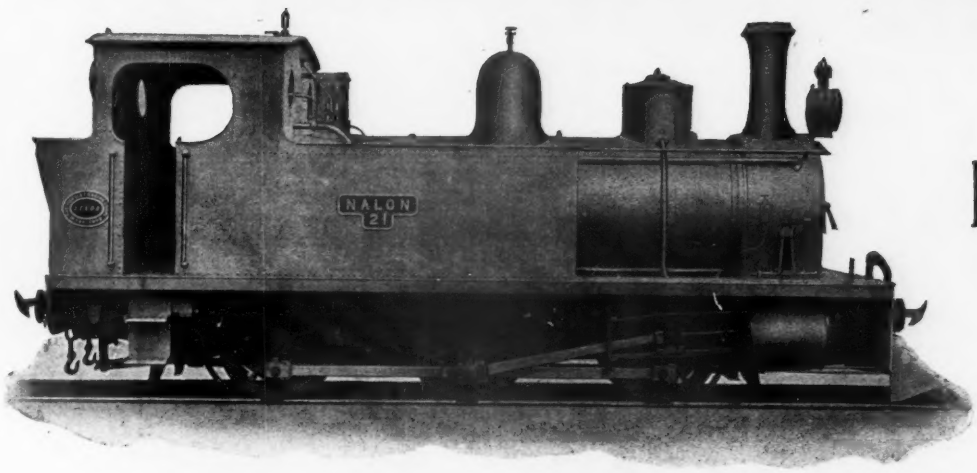


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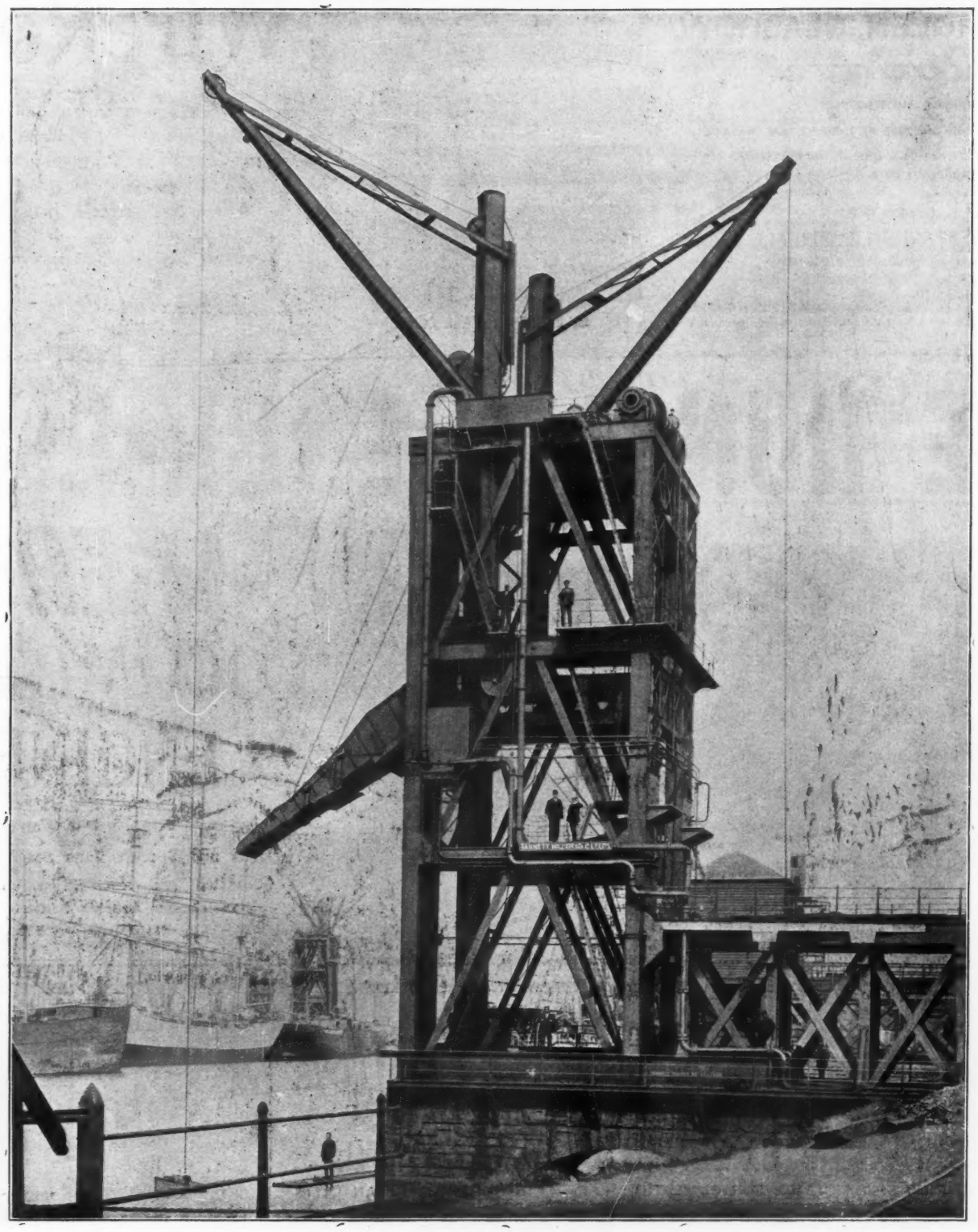

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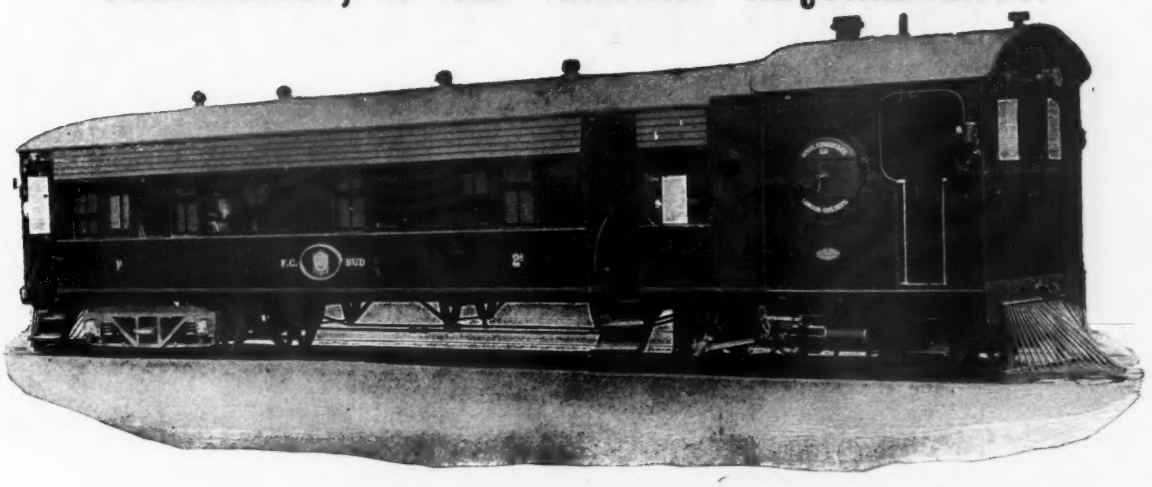

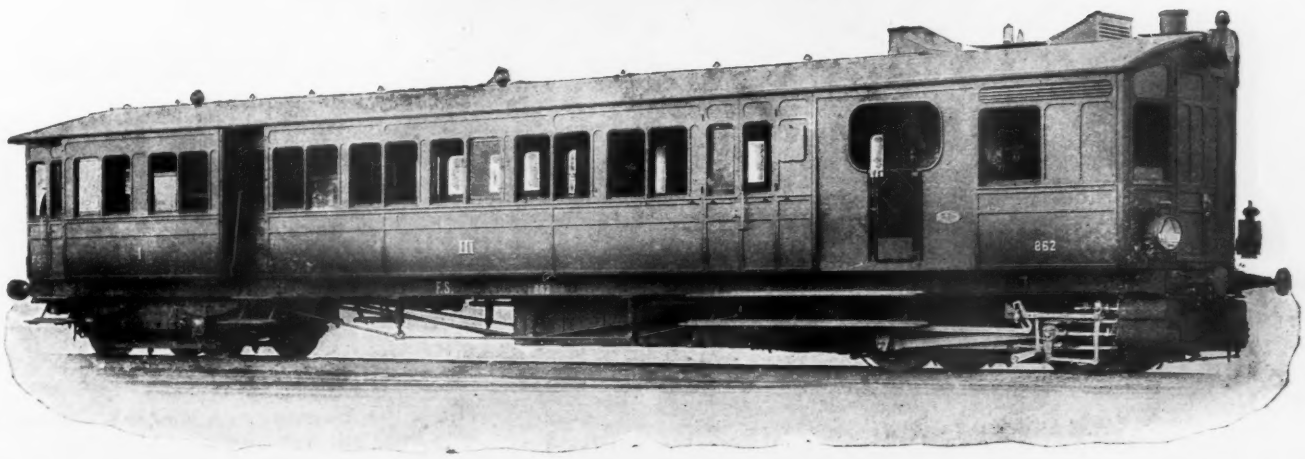

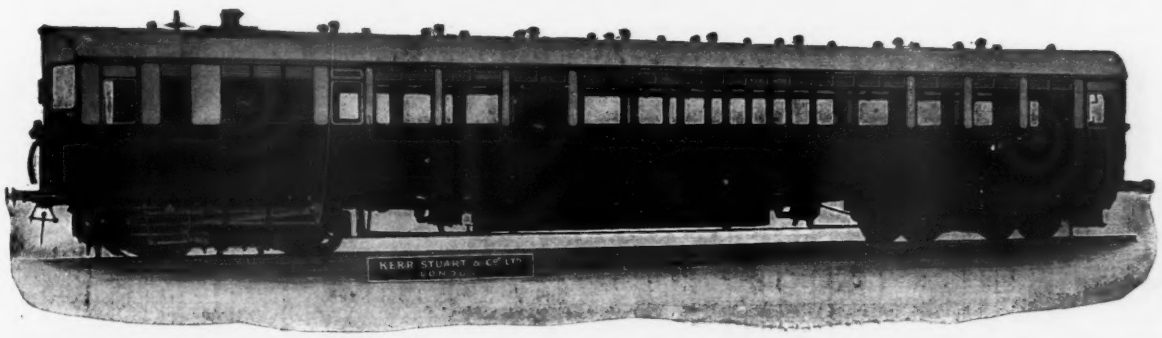


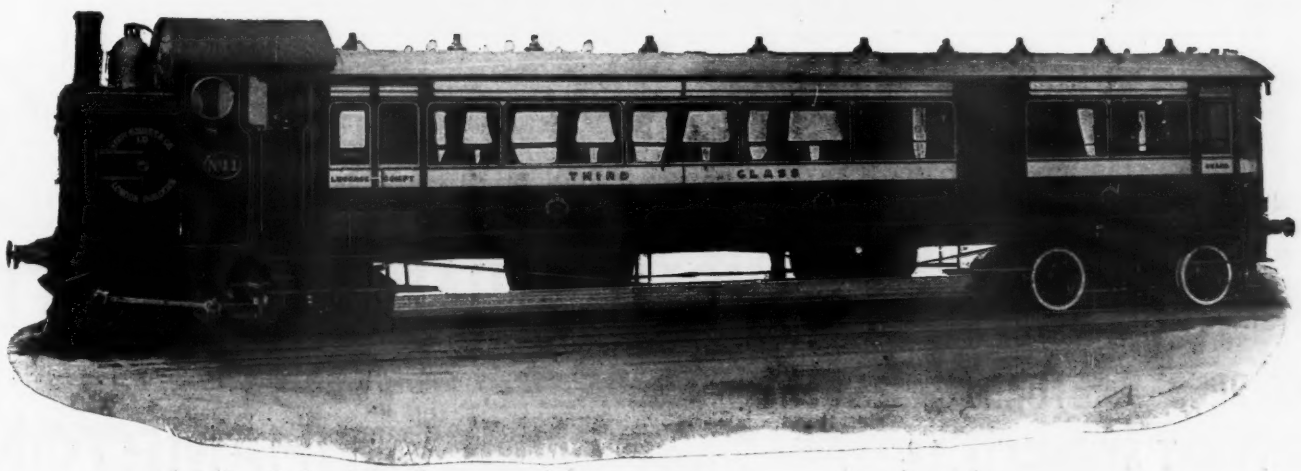


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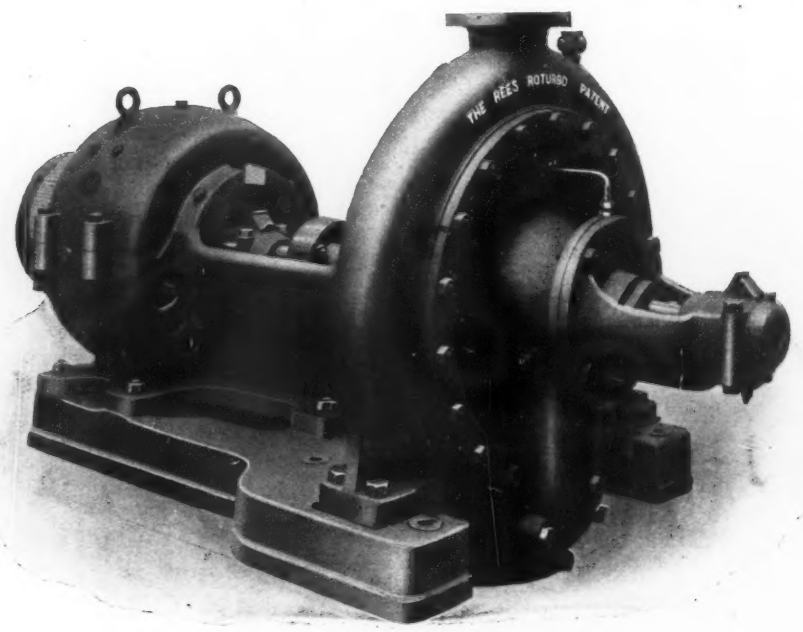


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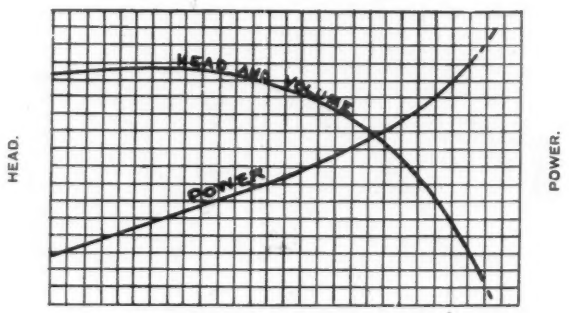


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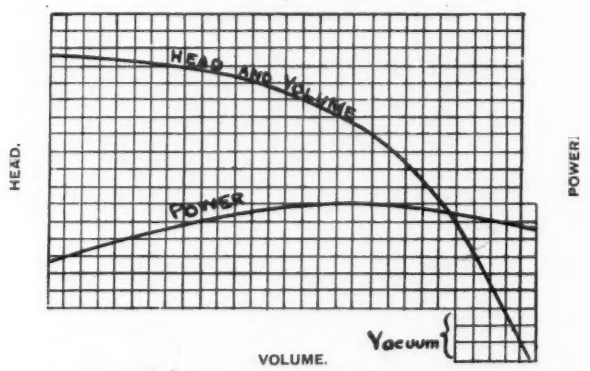


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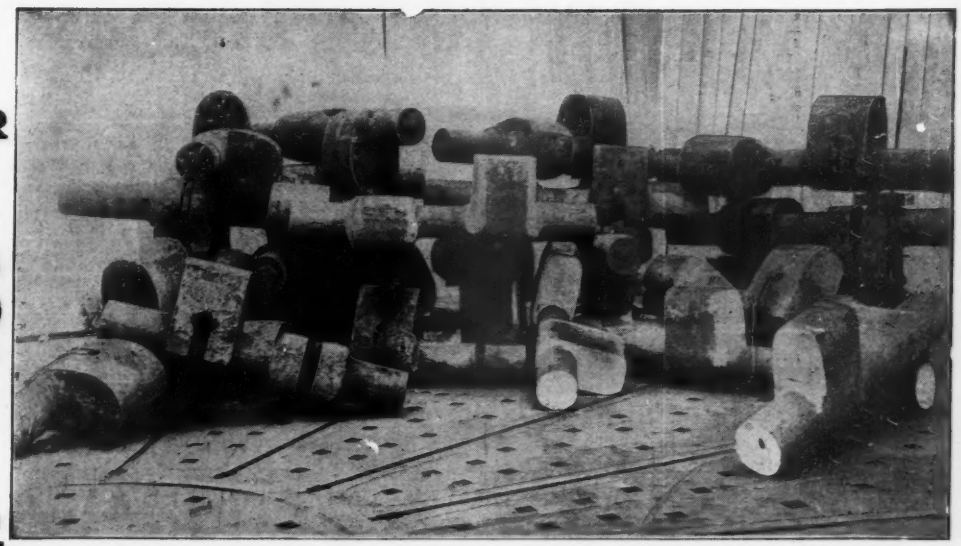

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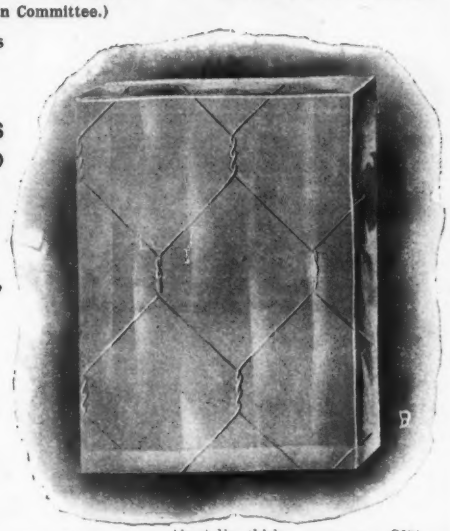

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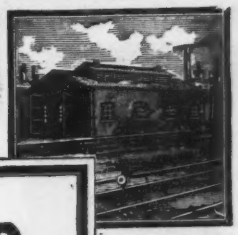

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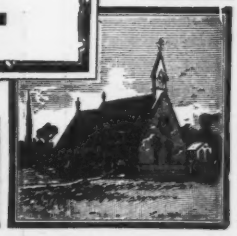

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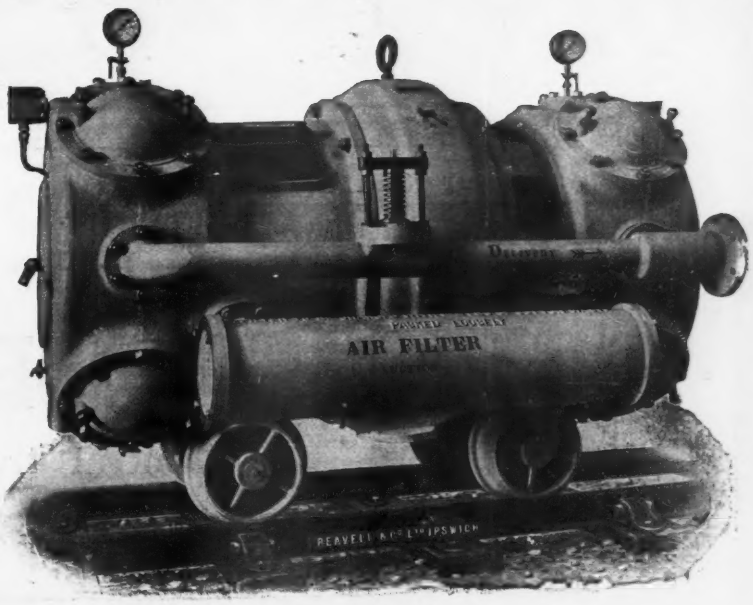


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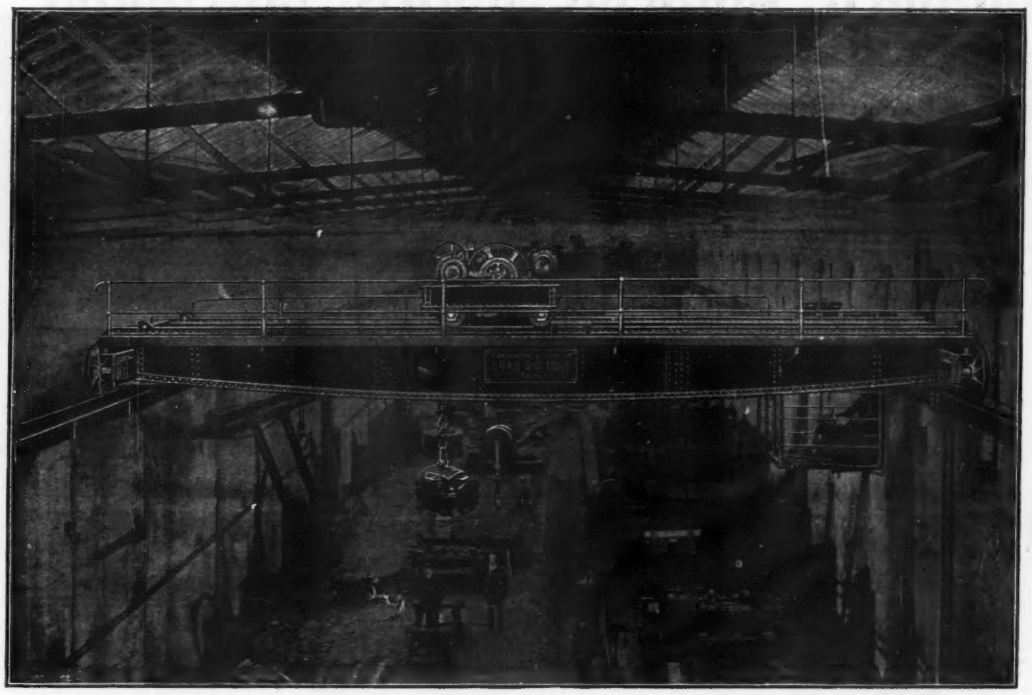

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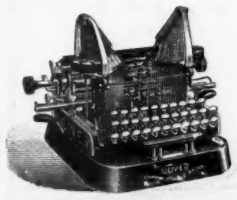

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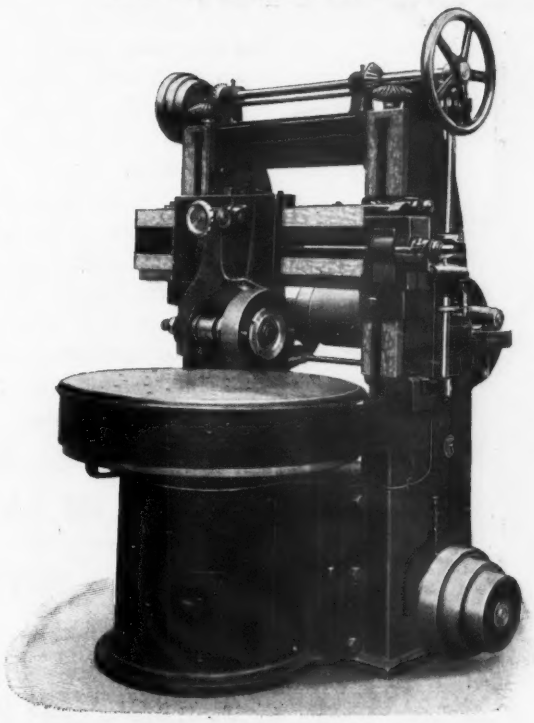

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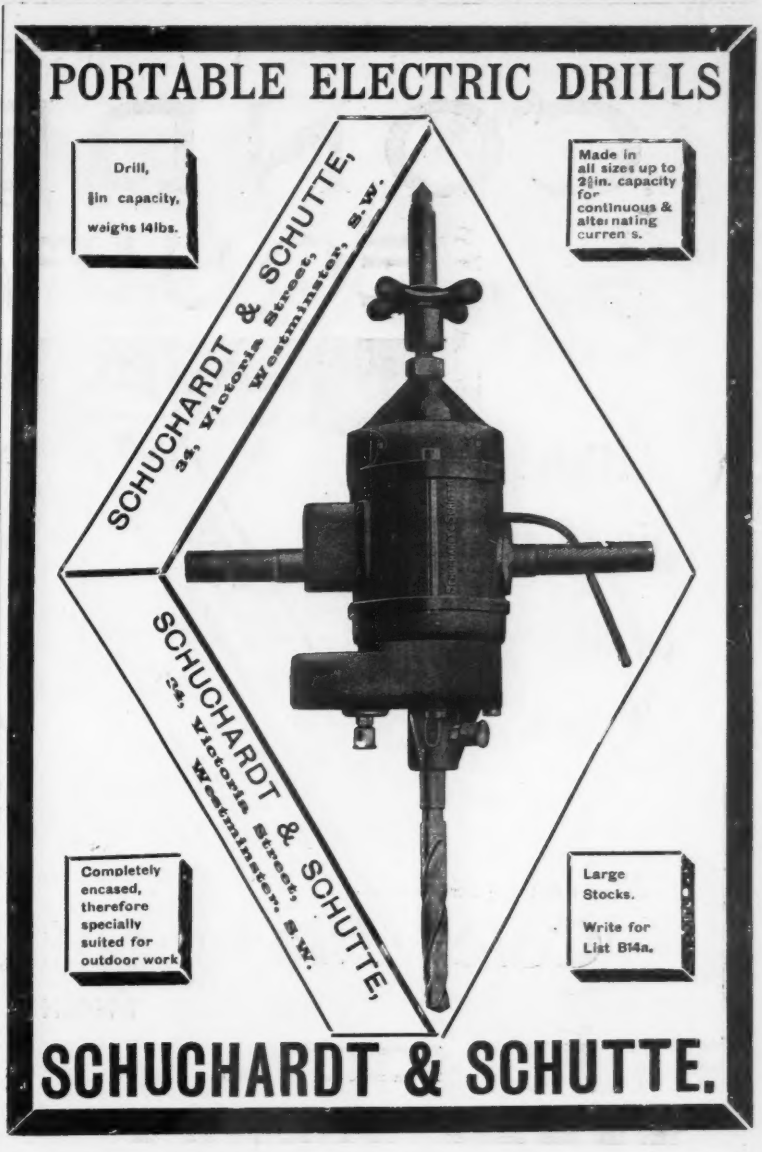
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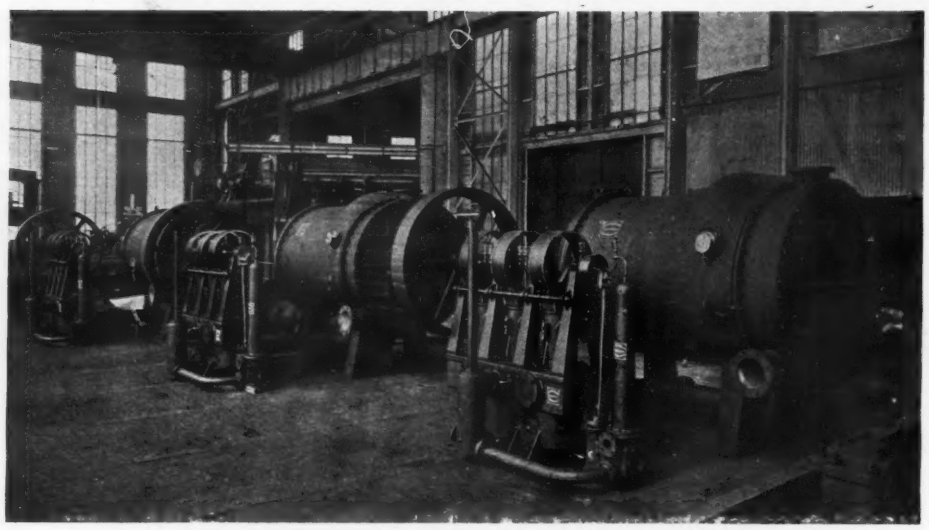

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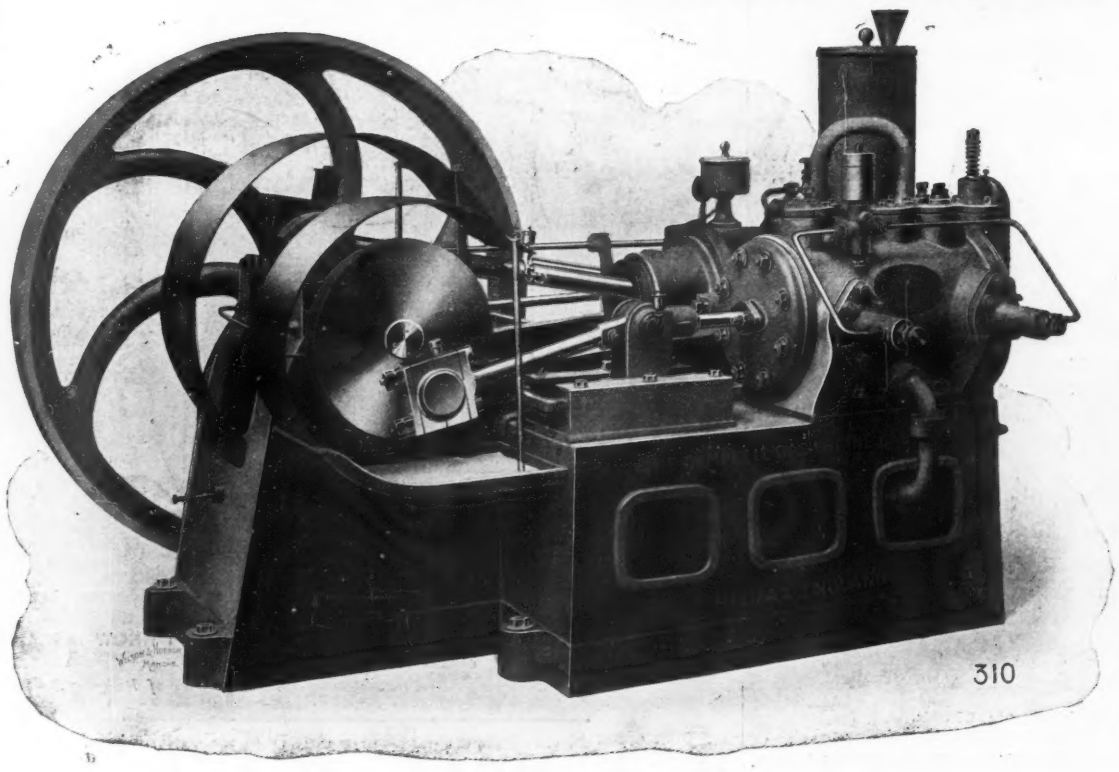


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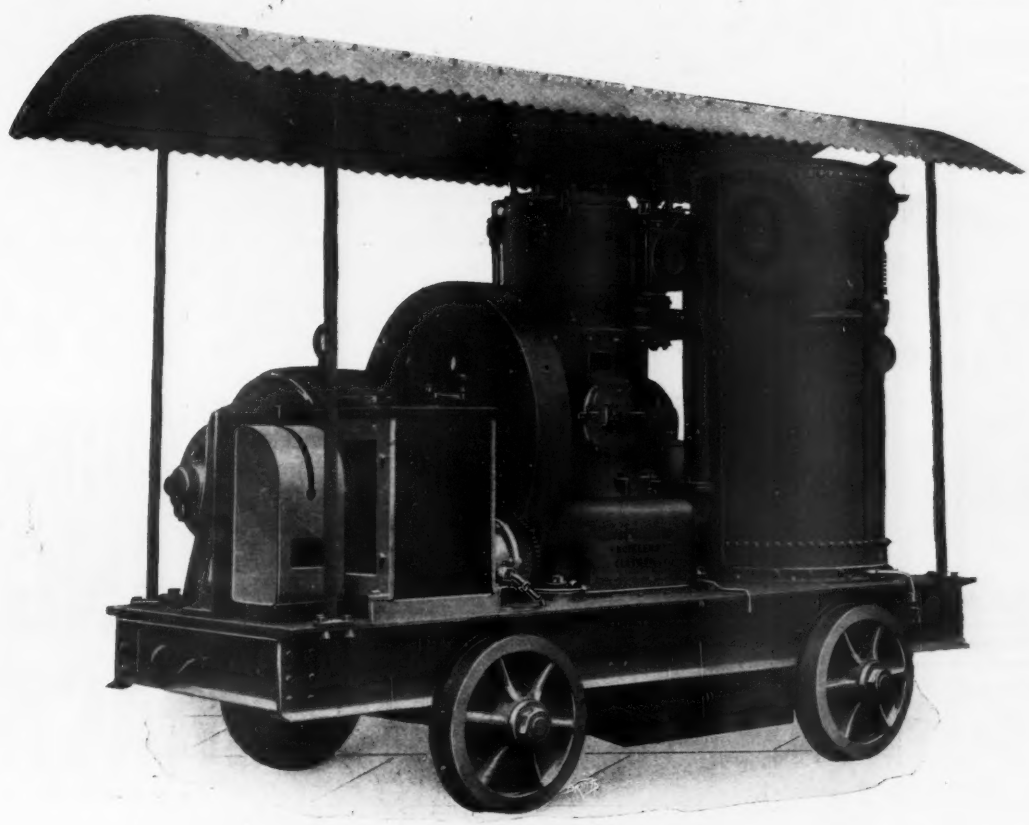

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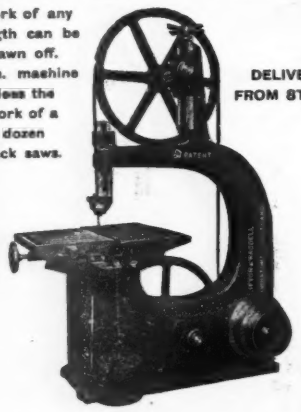

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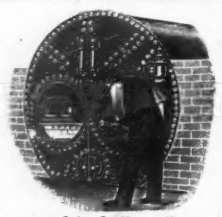

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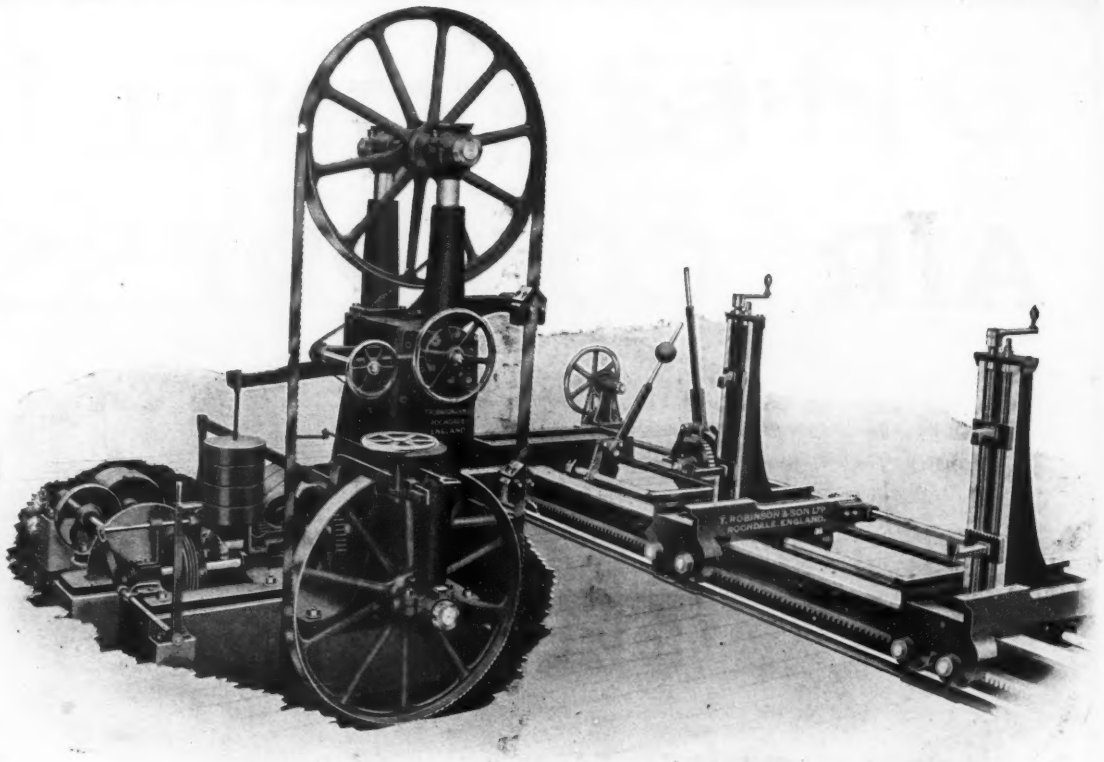

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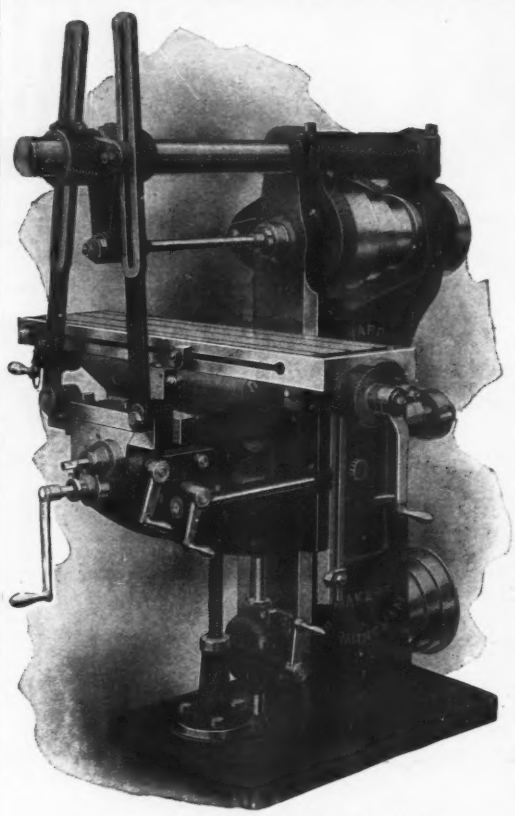

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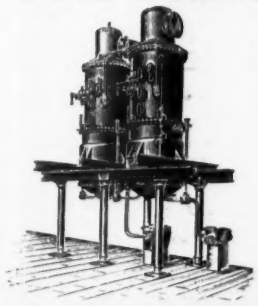

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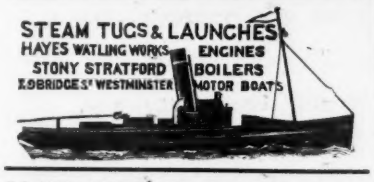


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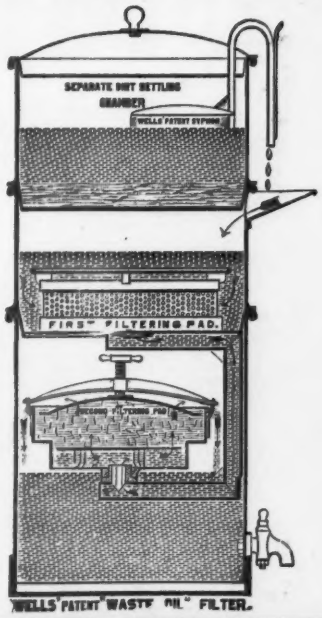

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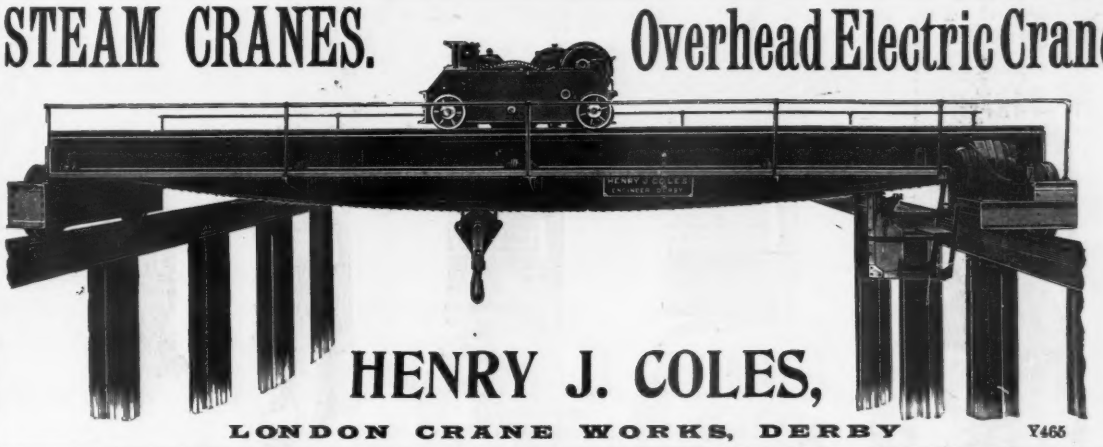

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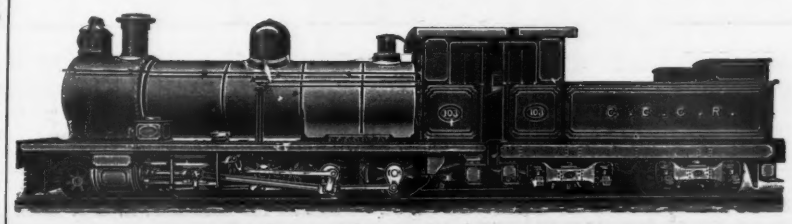

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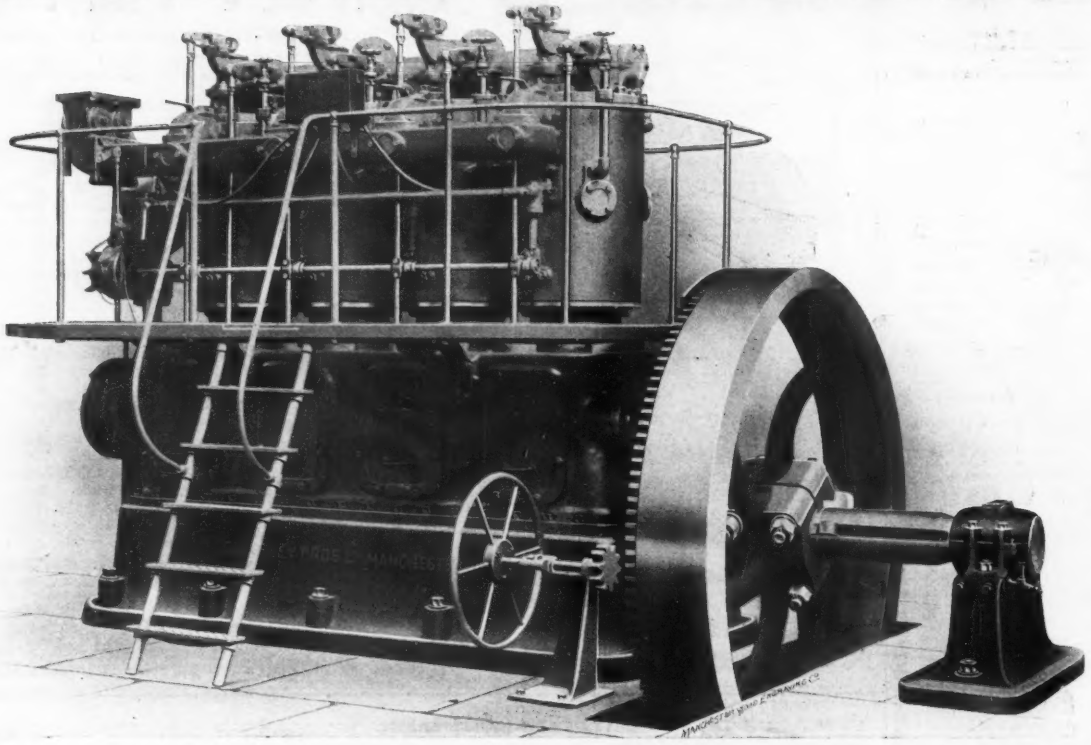

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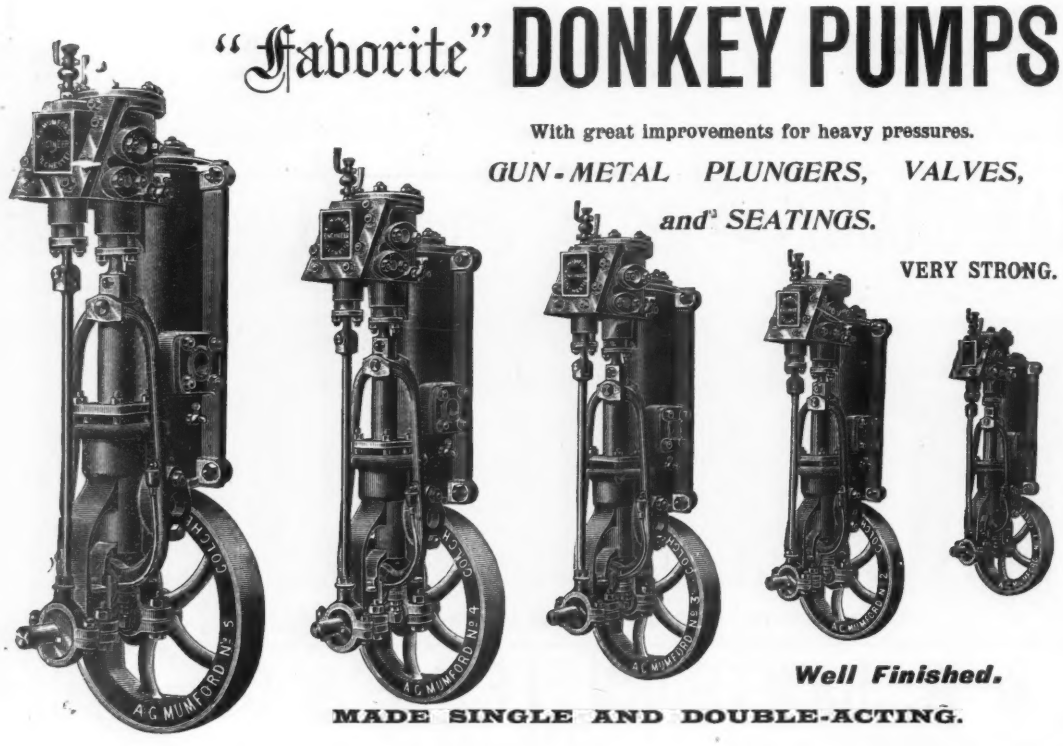


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|---|---|---|---|---|---|---|---|---|
| | No. 0. | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | No. 6. | No. 7. |
| Diameter of Ram .. | 1 | 1 1/8 | 1 1/8 | 2 1/2 | 2 3/4 | 3 1/2 | 3 1/2 | 4 |
| Diameter of Cylinder | 2 | 2 1/4 | 3 | 3 1/2 | 4 1/2 | 5 1/2 | 5 1/2 | 7 |
| Length of Stroke .. | 2 | 2 1/2 | 3 | 4 | 5 | 6 | 6 | 6 |
| Gallons per hour .. | 90 | 130 | 210 | 440 | 660 | 1000 | 1080 | 1280 |
| N.H.P. of Boiler .. | 4 | 5 | 10 | 30 | 45 | 70 | 72 | 80 |

| Sizes. | DOUBLE ACTION. | | | | | |
|---|---|---|---|---|---|---|
| | No. 3. | No. 4. | No. 5. | No. 6. | No. 7. | No. 8. |
| Diameter of Ram .. | 1 1/2 | 2 | 2 1/2 | 3 | 3 1/2 | 5 |
| Diameter of Cylinder | 3 | 3 1/2 | 4 1/2 | 5 1/2 | 6 | 7 |
| Length of Stroke .. | 3 | 4 | 5 | 6 | 6 | 6 |
| Gallons per hour .. | 420 | 800 | 1250 | 1820 | 2100 | 4000 |
| N.H.P. of Boiler .. | 32 | 70 | 90 | 120 | 150 | 250 |

O1506

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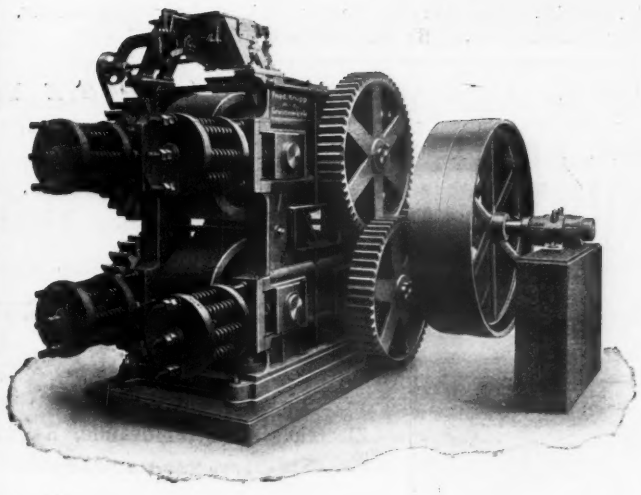

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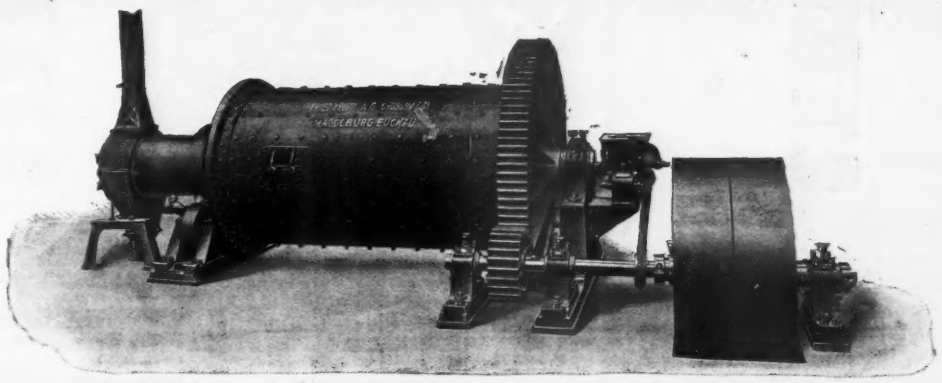

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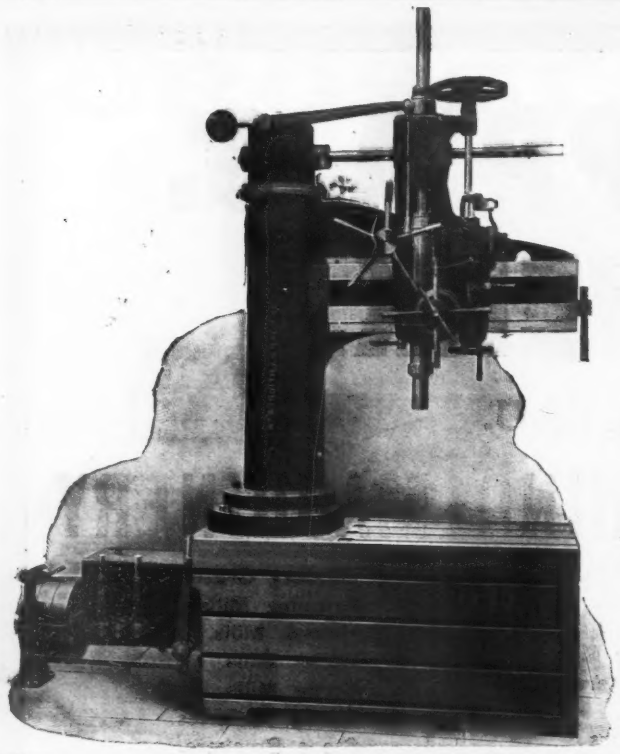

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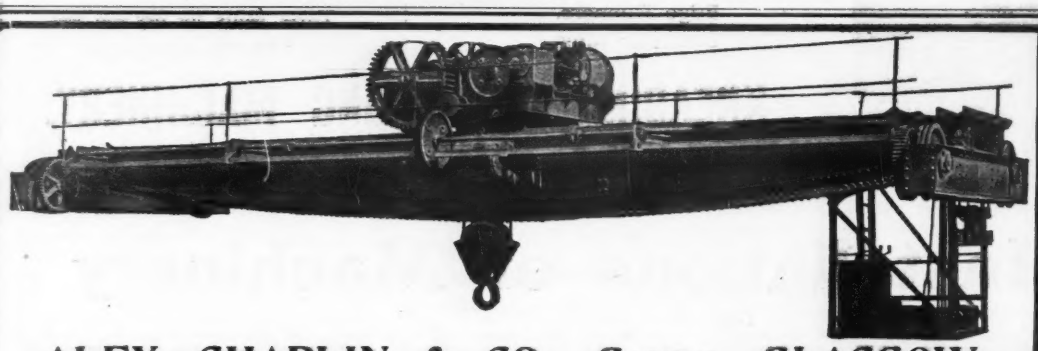

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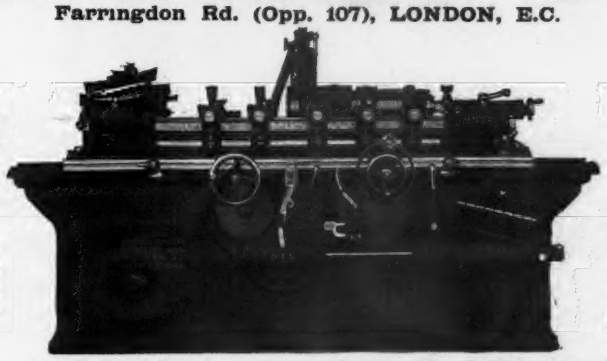

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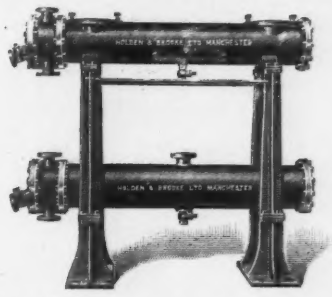

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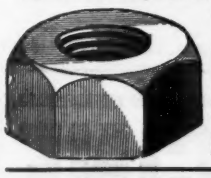

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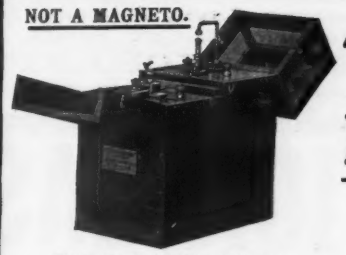

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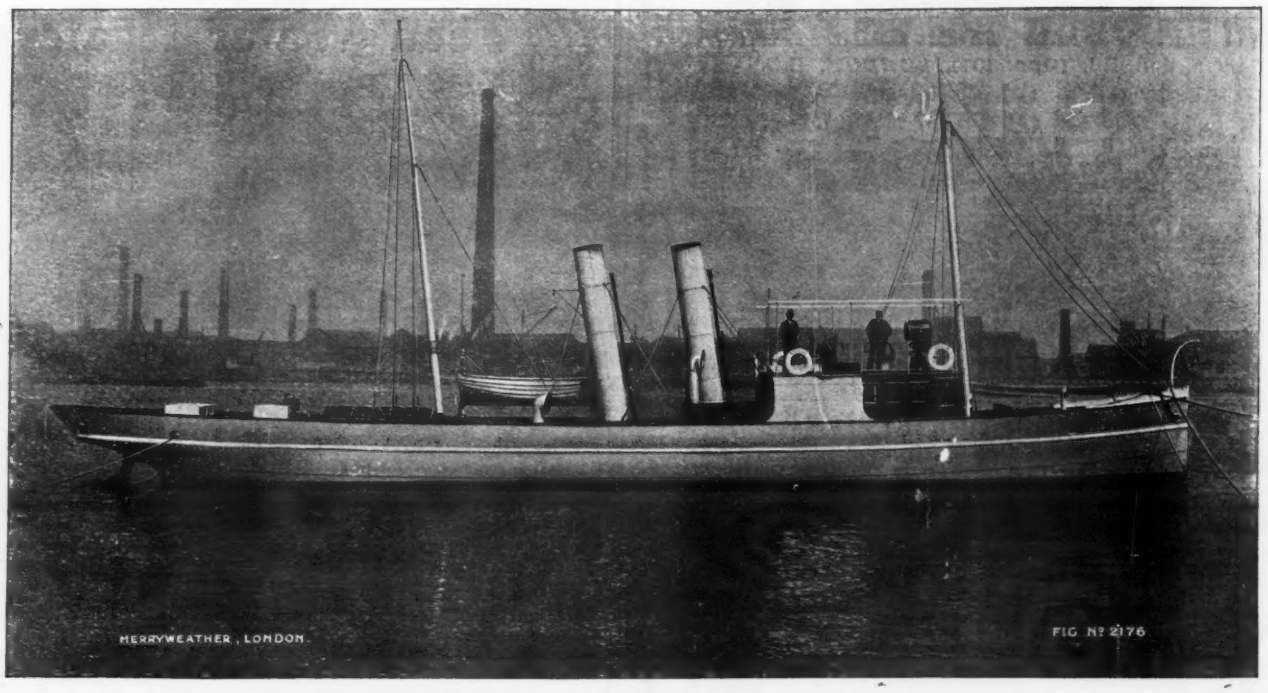


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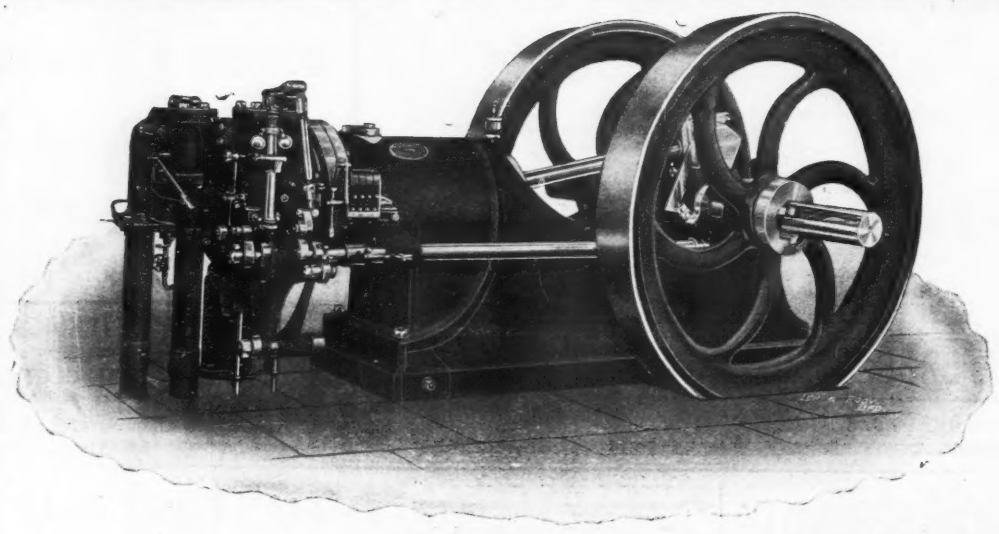

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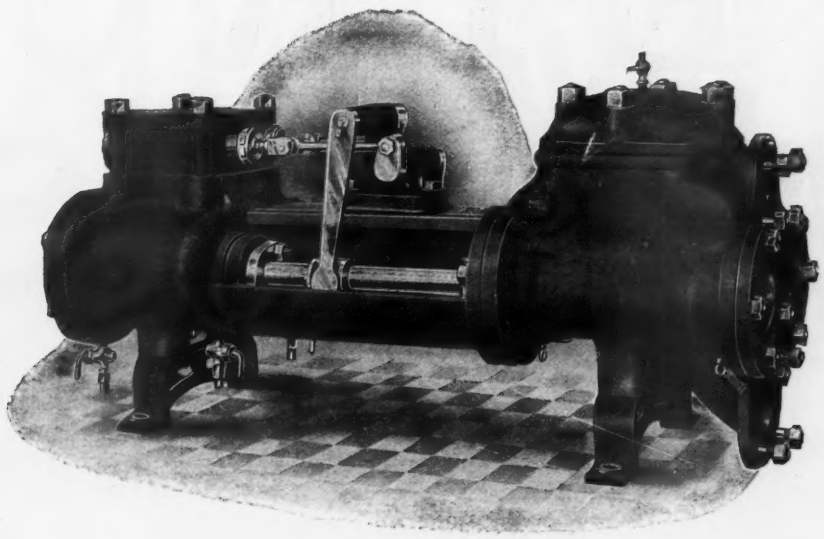

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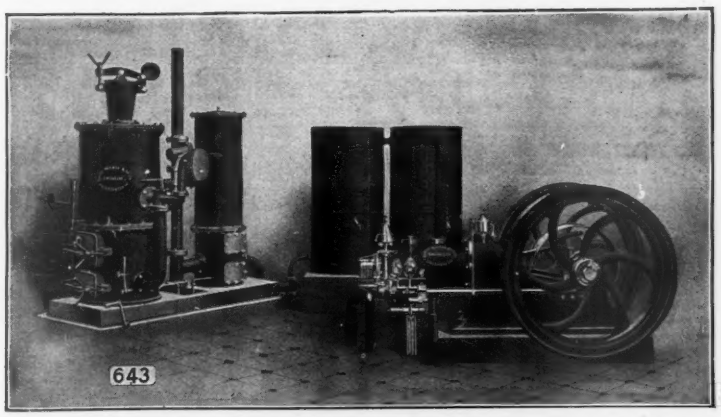


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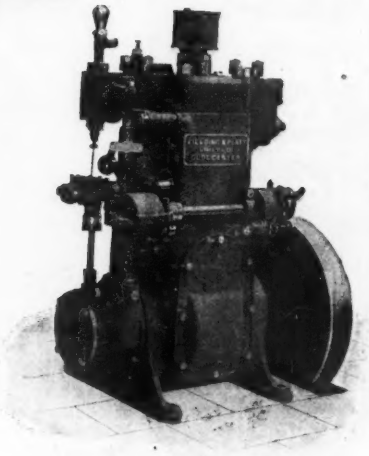

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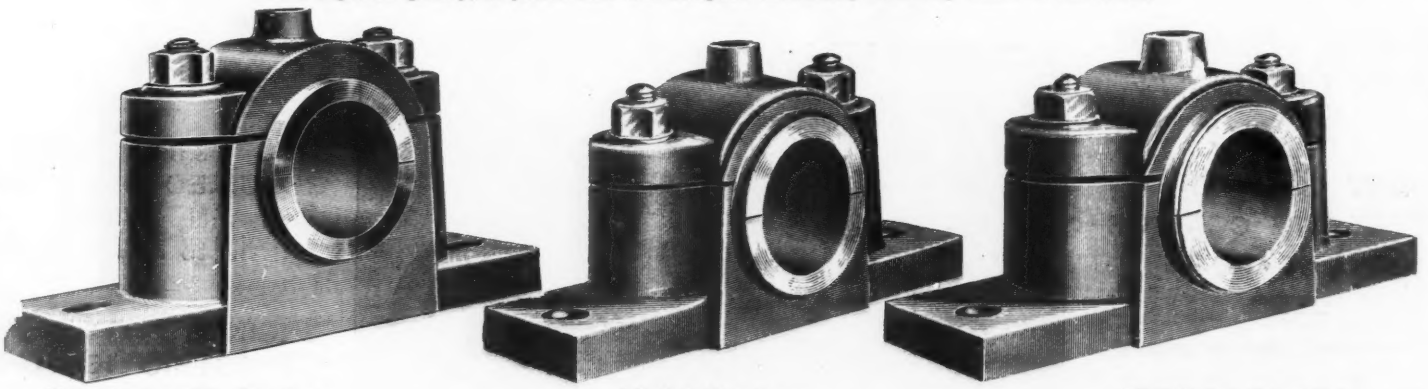

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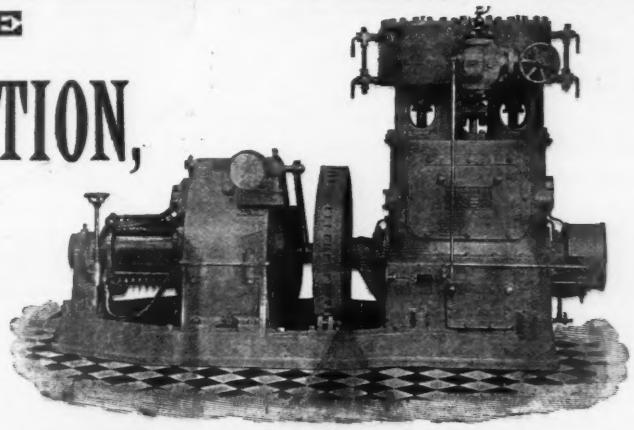
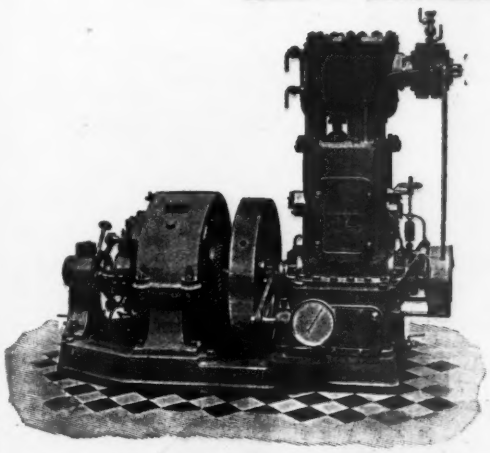


**Output 100 kw. Compound Engine and Continuous Current Dynamo.**



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**STEAM, MOTOR, or BELT DRIVEN**

## Centrifugal Pumping Plants

***OF ANY SIZE.***

**STEAM & MOTOR DRIVEN**

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**Complete Estimates and Tenders will be submitted on receipt of particulars and requirements.**

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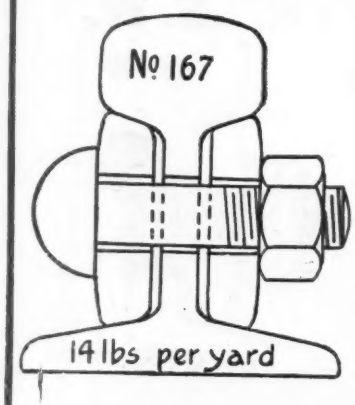
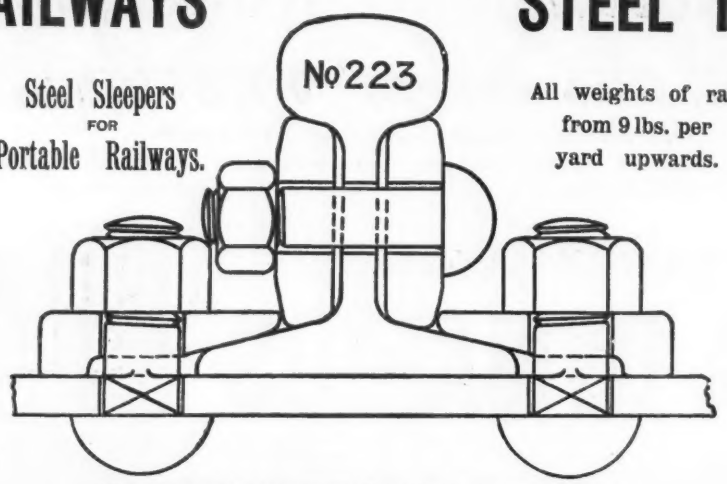
## PORTABLE RAILWAYS

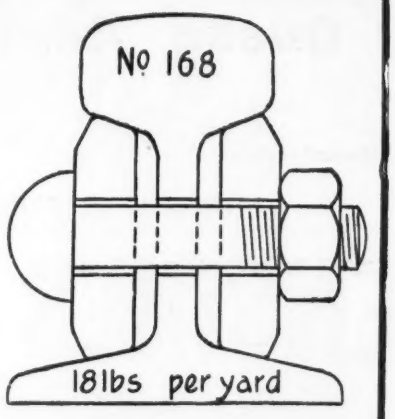
## STEEL TIPPING WAGONS




Steel Sleepers FOR Portable Railways.

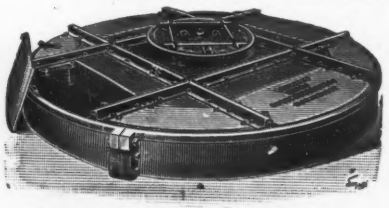



All weights of rail from 9 lbs. per yard upwards.

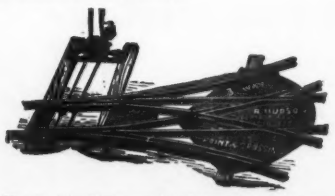



STEEL TROUGH OR CORRUGATED SLEEPER, WITH BOLTED CLIPS.

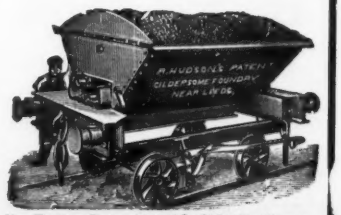
**No. E. 96—Patent Double Centre Steel Side Tip Wagon** (Diamond Fields Pattern), with jockey for wire rope haulage.



**No. E. 115—Self-contained Turntable.**



**No. E. 11—Right and Left-hand Three-way Steel Point and Crossing.**

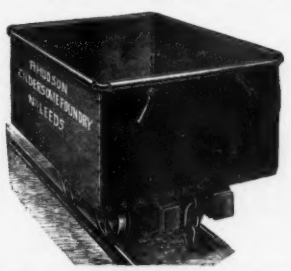



**No. E. 59.—Patent Double Side Tip Wagon.** To work with ordinary Railway Wagons made to any size. Can be tipped by one man.

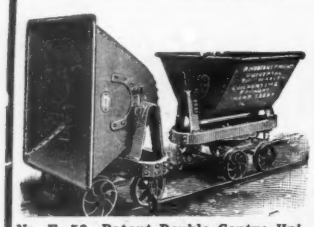
**No. E. 1—Patent Steel End Tip Wagon.**

**No. E. 22—Two Tons Steel Plate Bogie.** "Practically Indestructible." Always in Stock. Platform about 56in. long by 30in. wide. Height 23in. Weight about 4 cwts. 18in. Steel Wheels.

**No. E. 76—Hand Trolley,** made to carry any weight, or to suit any rail gauge.

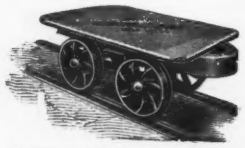



**No. E. 101—Steel Plate Colliery Truck.**



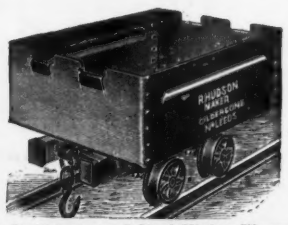
**No. E. 50—Patent Double Centre Universal Tip Wagon,** tipping either Endways or Sideways at will.

**No. E. 162—Patent Steel Double Side Tip Wagon,** with screw brake and platform.



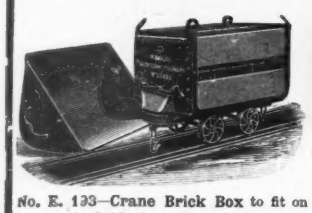
**No. E. 58—Steel Plate Bogie.**

**No. E. 86—Steel Tip Buckets.**




**No. E. 104—Pressed Steel Mining Wagon.**

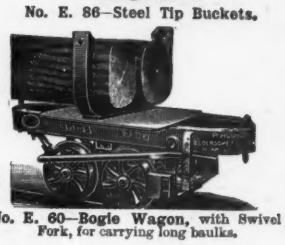
**No. E. 97—Steel Side and End Tip Wagon,** with Flapping Door (for hand use).



**No. E. 133—Crane Brick Box** to fit on standard side tip wagon underframe.

**No. E. 171—Coke-charging Barrow,** with end door.

**No. E 15—Steel Cage.** With Safety Grippers and Fallers complete.



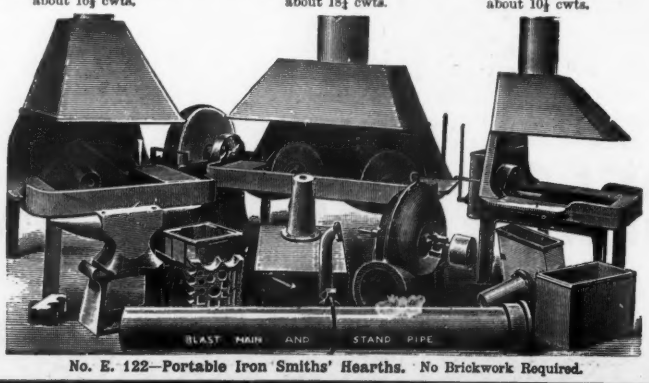

**No. E. 60—Bogie Wagon,** with Swivel Fork, for carrying long baulks.

**No. E. 106—Steel Hopper Wagon,** with sliding door worked by lever.

"A GREAT SUCCESS."

**No. E. 16—Patent Steel Barrows.** Practically Indestructible.

5ft. × 5ft. HEARTH, about 16½ cwts. DOUBLE HEARTH, about 18½ cwts. 3½ft. × 4ft. HEARTH, about 10½ cwts.




**No. E. 122—Portable Iron Smiths' Hearths.** No Brickwork Required.

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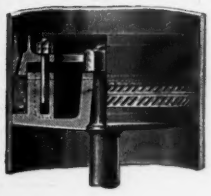
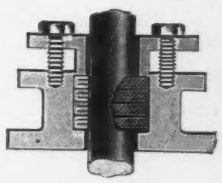
Supplied in Lengths or Rings.



When ordering Rings give diameter of Rod and Stuffing Box.



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| Piston Glands of Galloway Blowing Engine ... ... ... ... ... | 25 lb. | Aug. 12, 1899 | March, 1902 | 2 yrs. 7 mths. | |
| High-pressure Gland of Finishing Mill Engine ... ... ... ... | 145 lb. | Feb. 27, 1900 | March, 1903 | 3 yrs. 1 mth. | |
| Piston Glands of Galloway Engine... | 70 lb. | Nov. 11, 1899 | May, 1903 | 3 yrs. 6 mths. | |
| Piston Glands of Roughing Mill Engine ... ... ... ... ... | 70 lb. | Nov. 17, 1900 | Nov., 1903 | 3 years | |
| Piston Glands of Cogging Mill Engine ... ... ... ... ... | 70 lb. | July 12, 1900 | May, 1903 | 2 yrs. 10 mths. | |
| **TRIPLE EXPANSION FURNACE BLOWING ENGINE** ... ... | **180 lb.** | **Feb. 27, 1901** | **Still in** One new turn of packing added | **3 yrs. 6 mths.** | |

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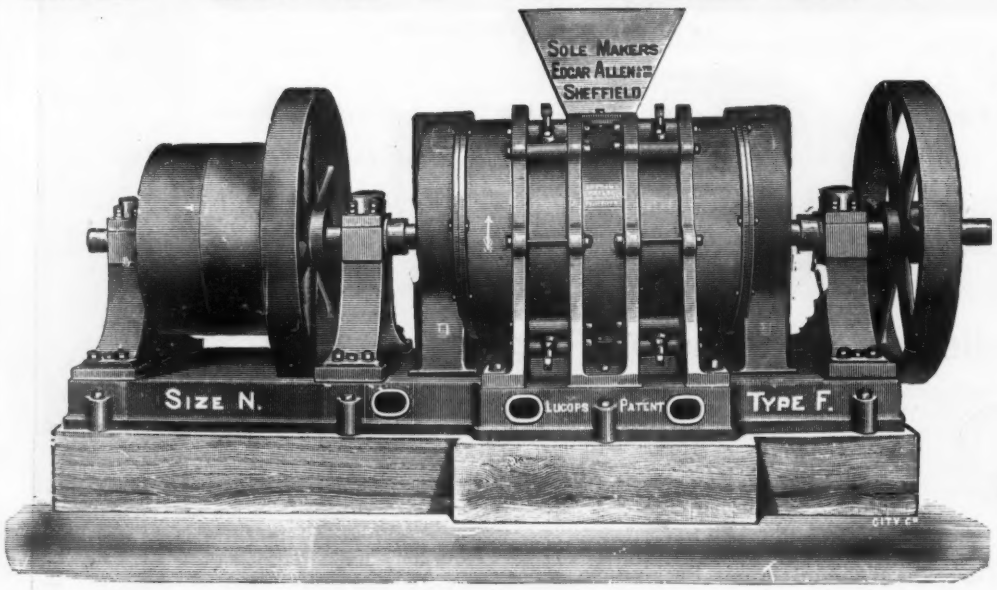


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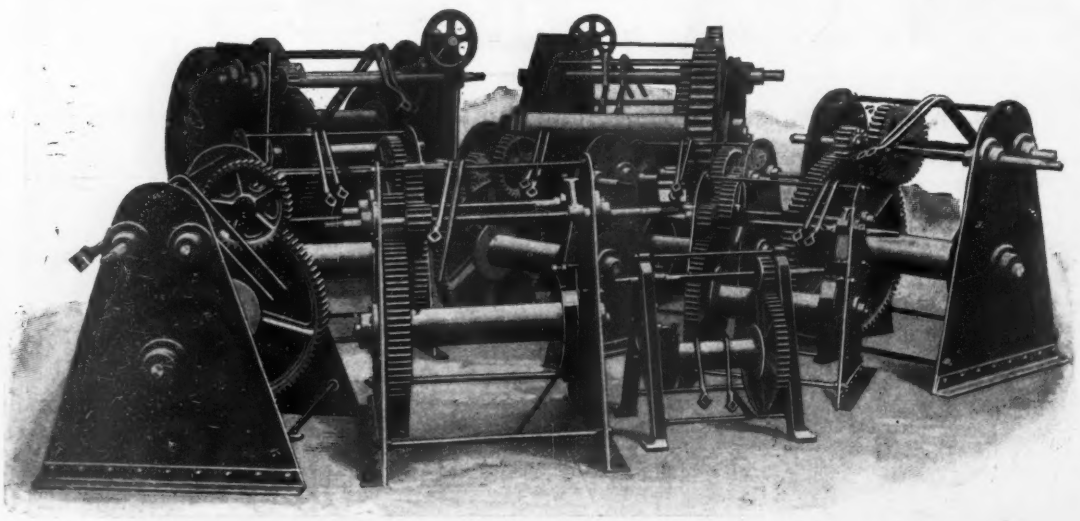

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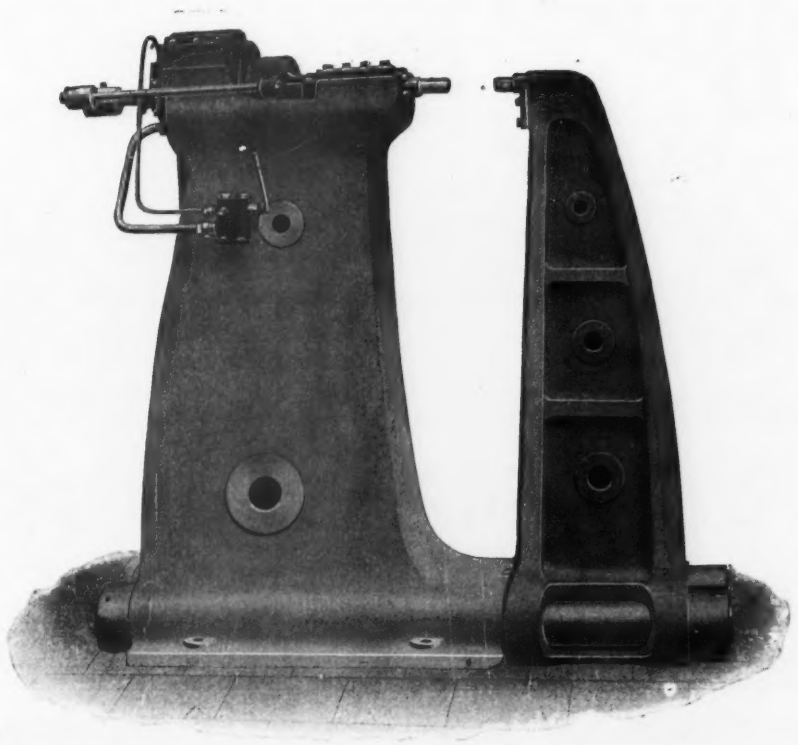

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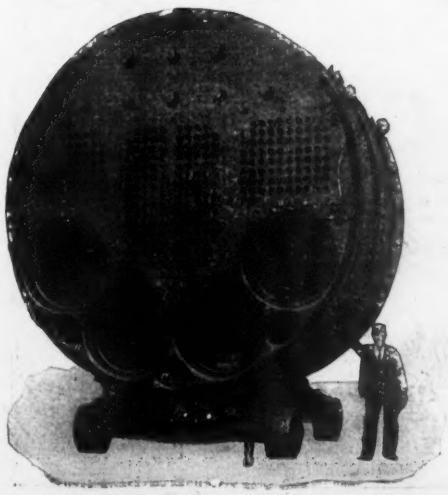

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# LOOK AT PAGE 33

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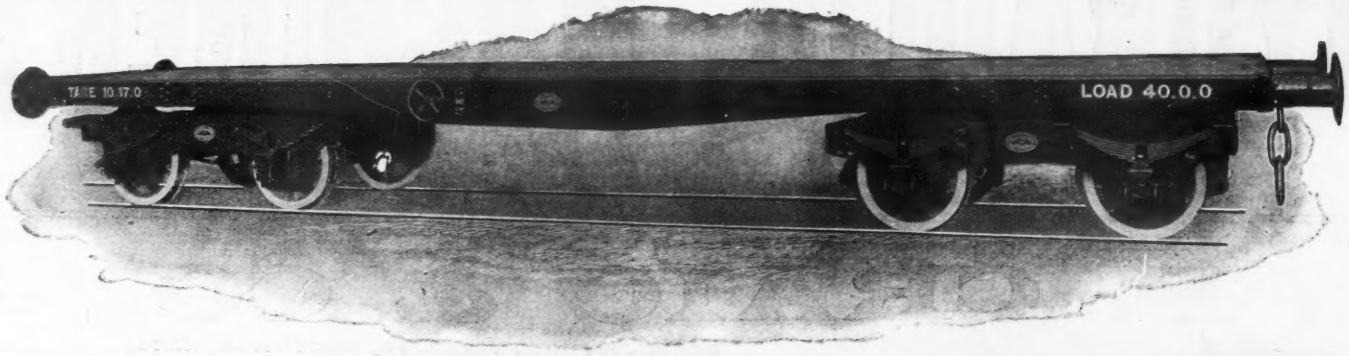


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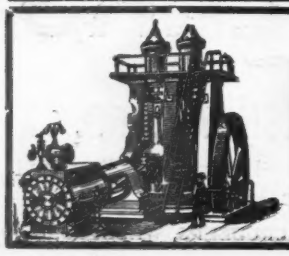

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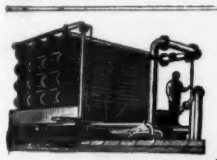

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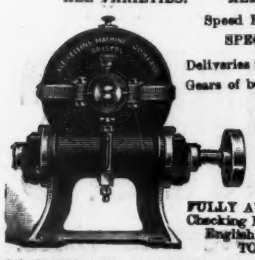

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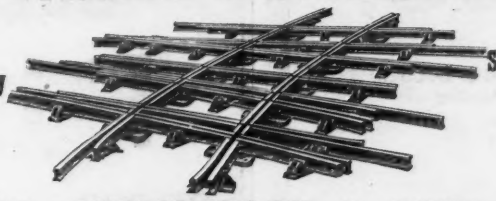

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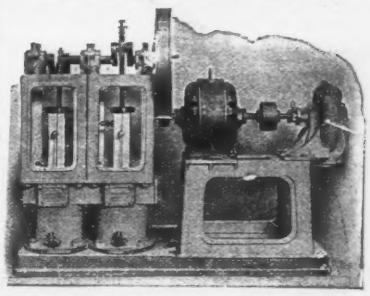

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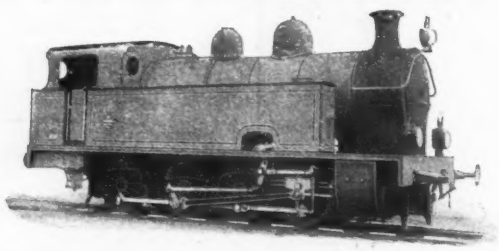

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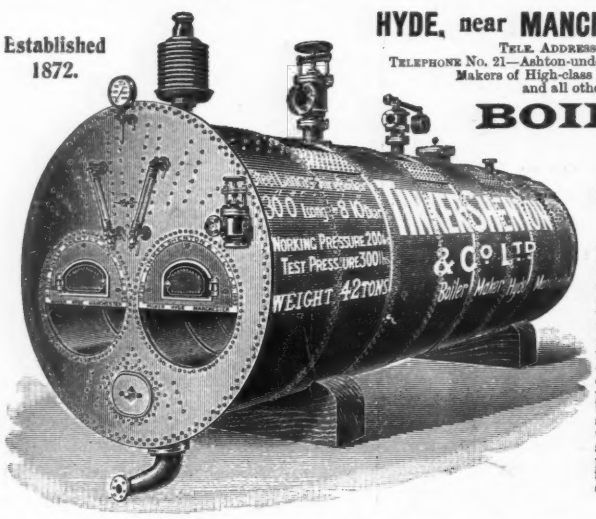


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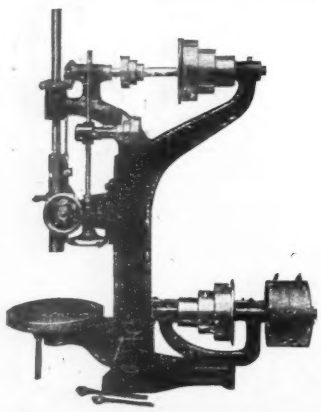

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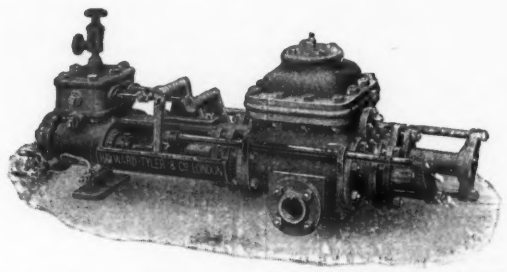

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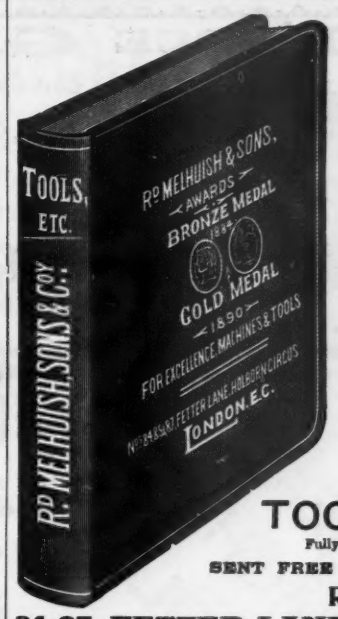


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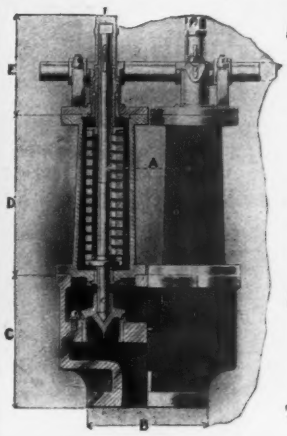

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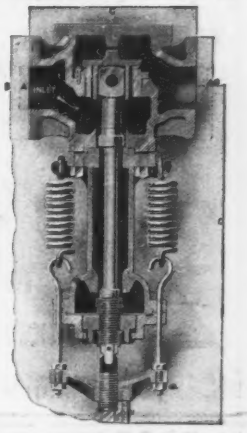

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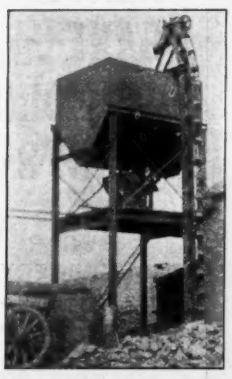

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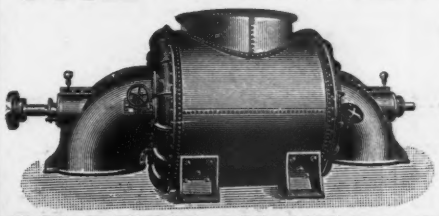

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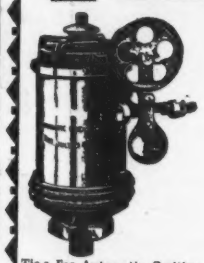

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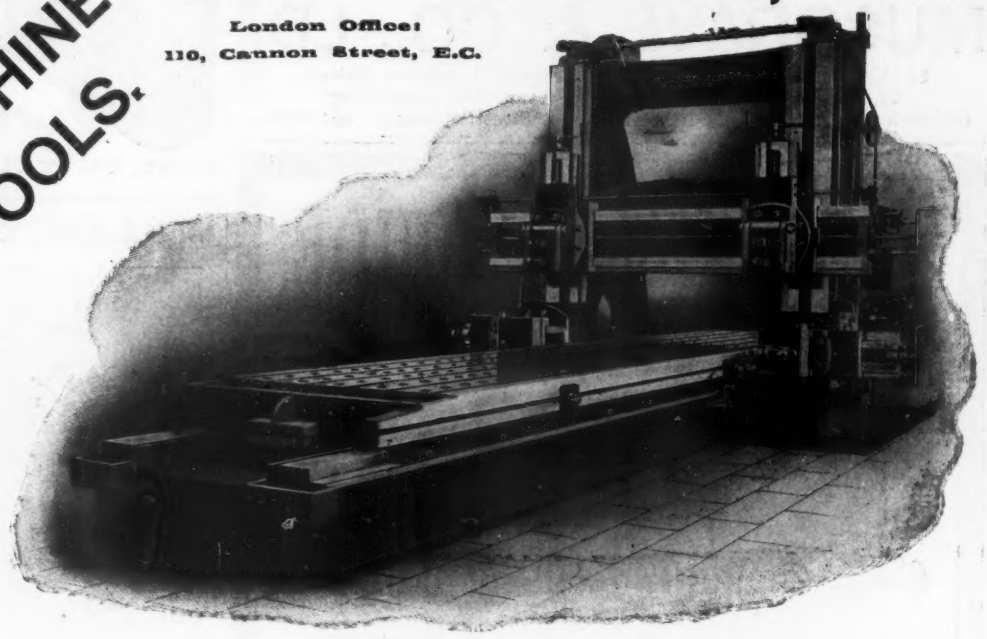

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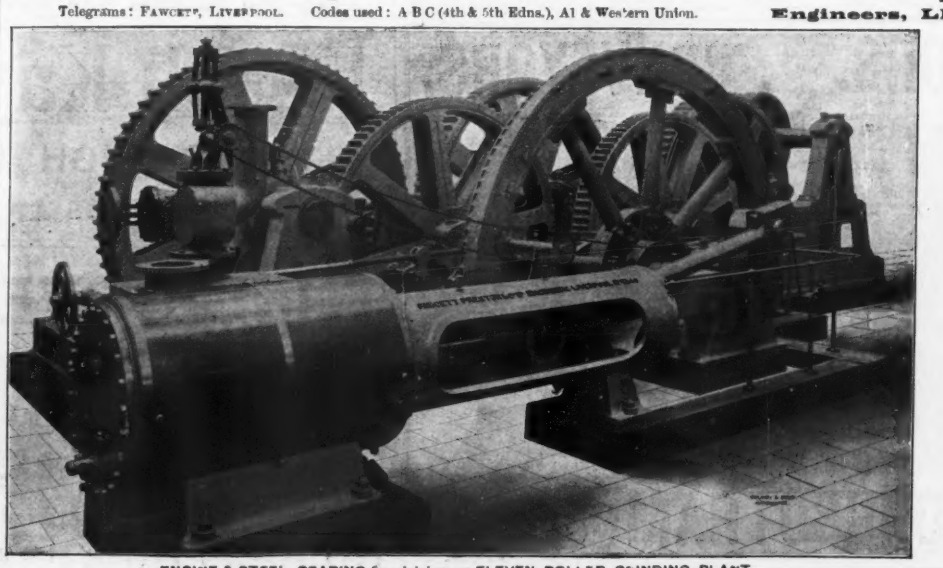

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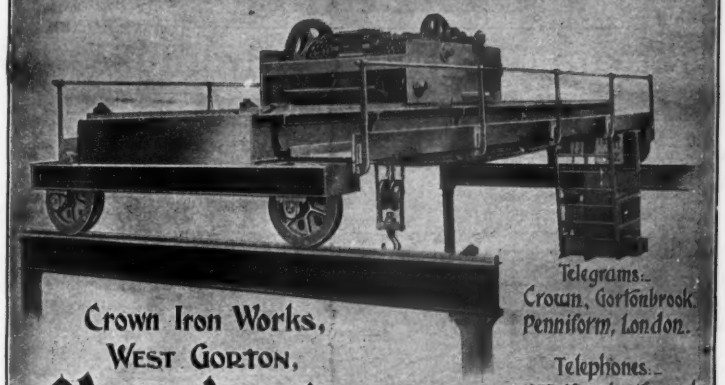

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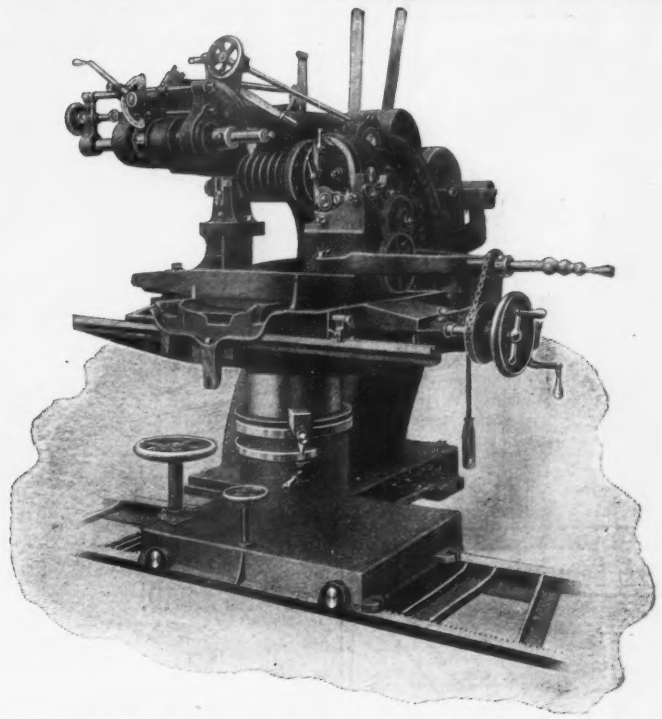

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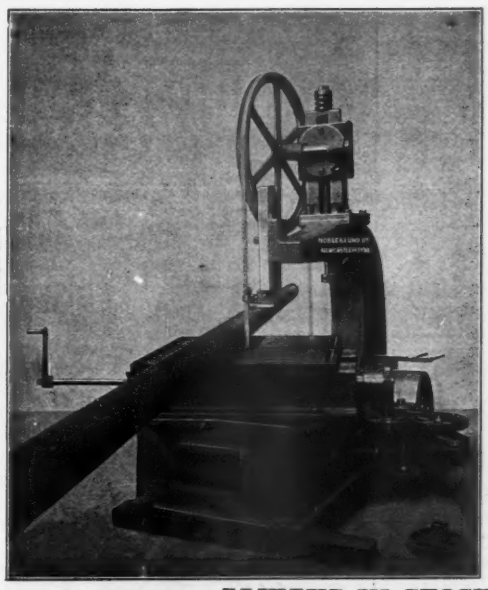

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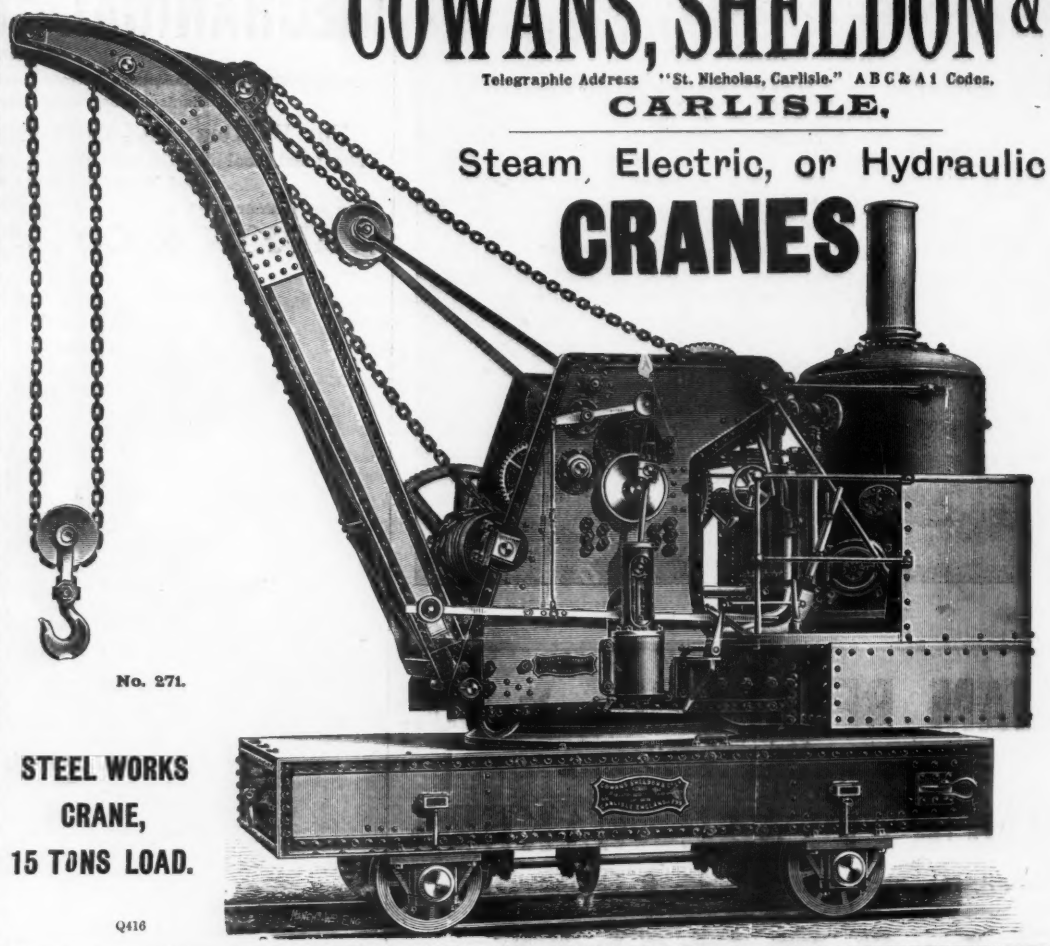

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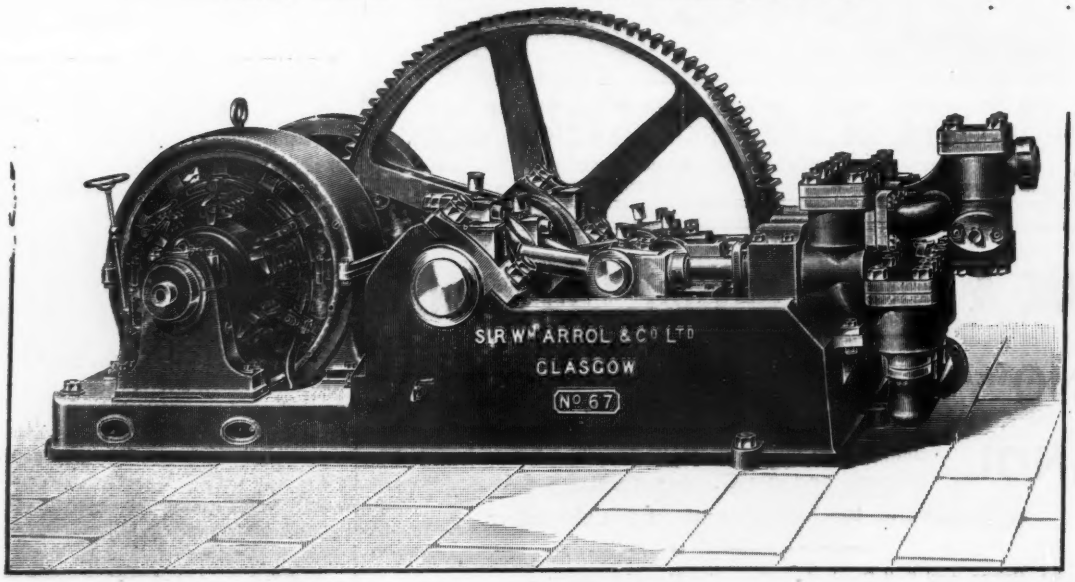


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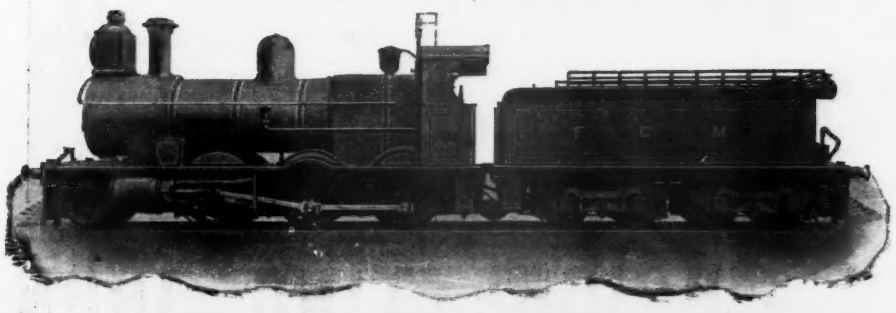

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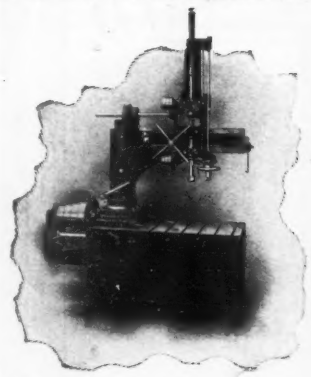

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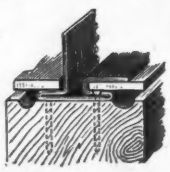

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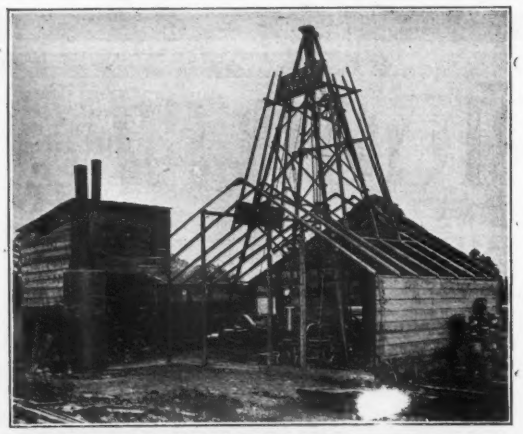

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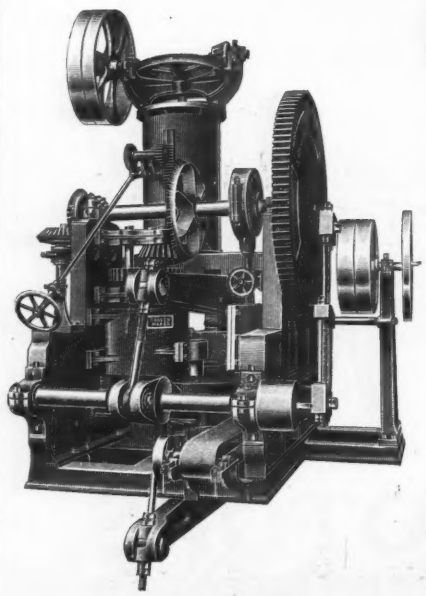

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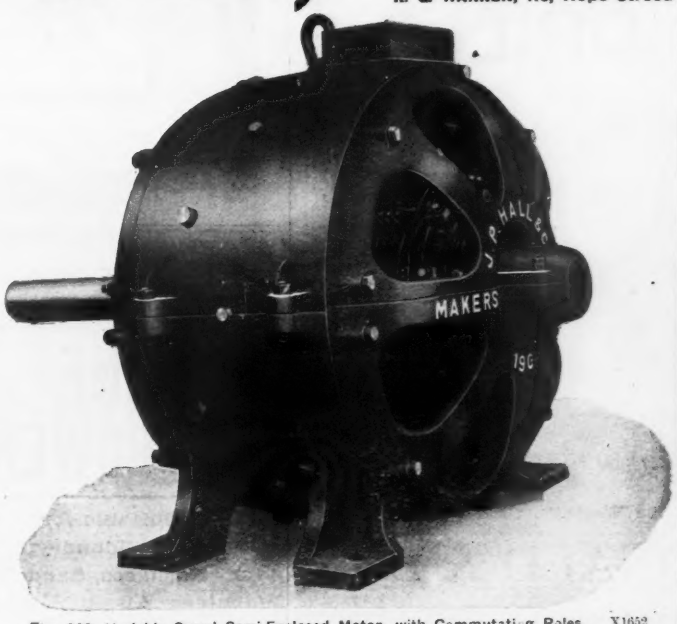


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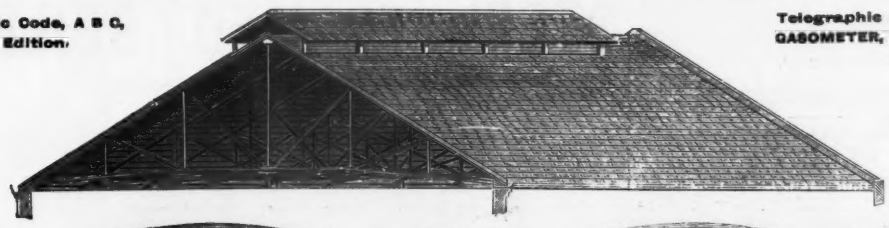

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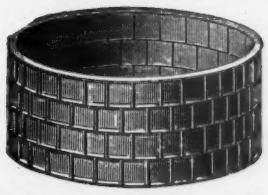

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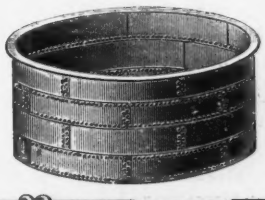

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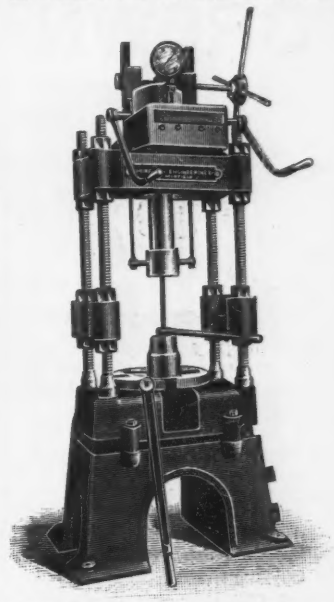

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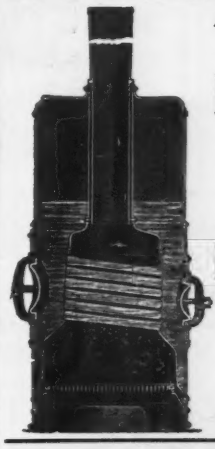

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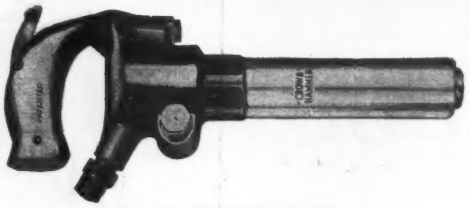

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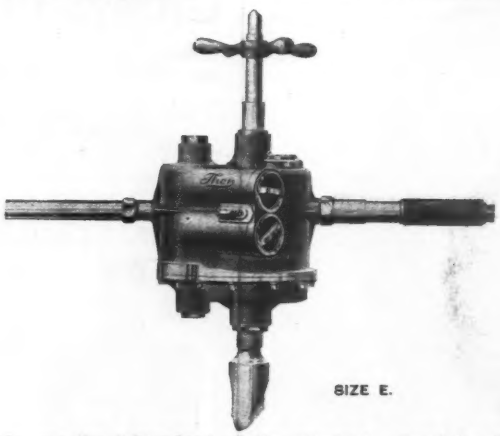

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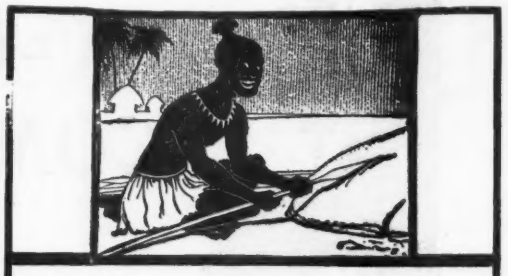

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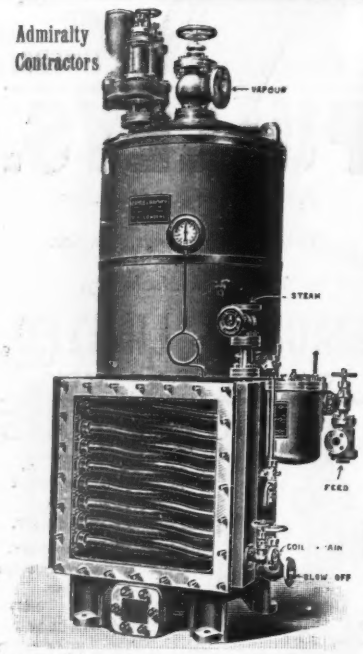


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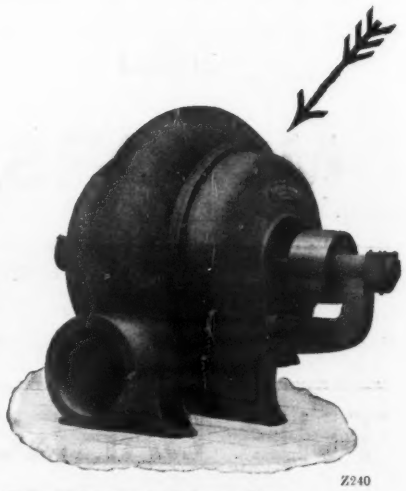

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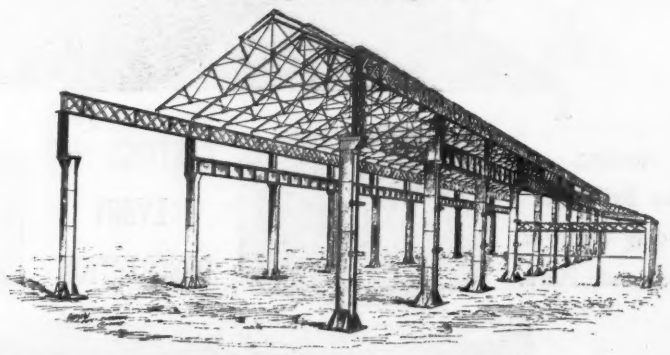

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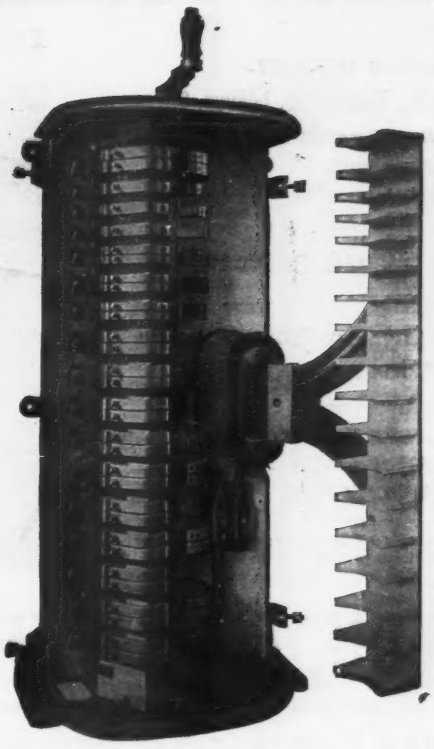

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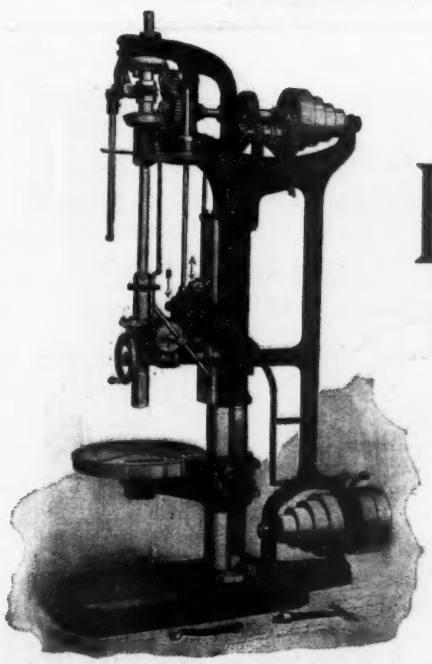

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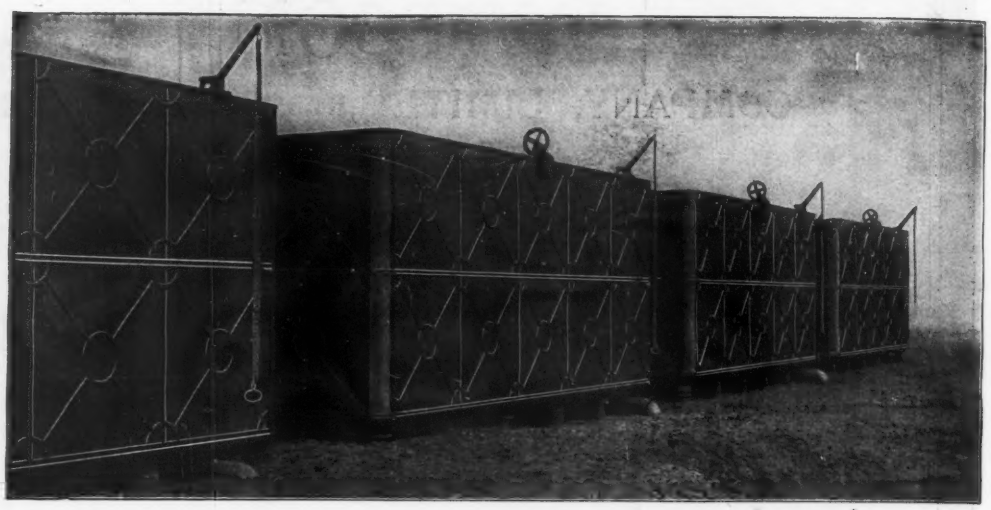

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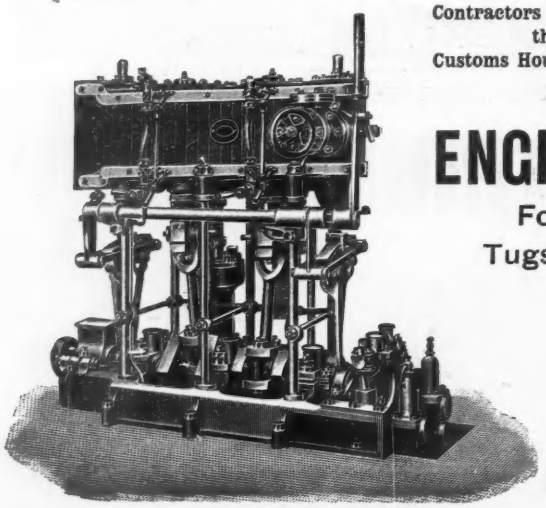

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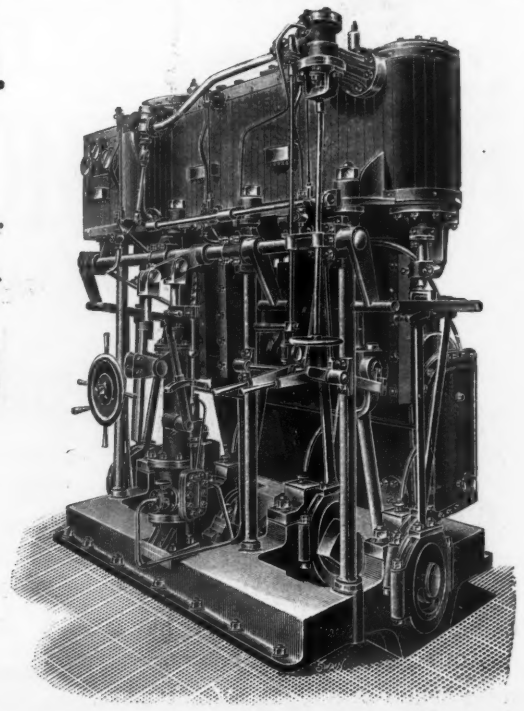

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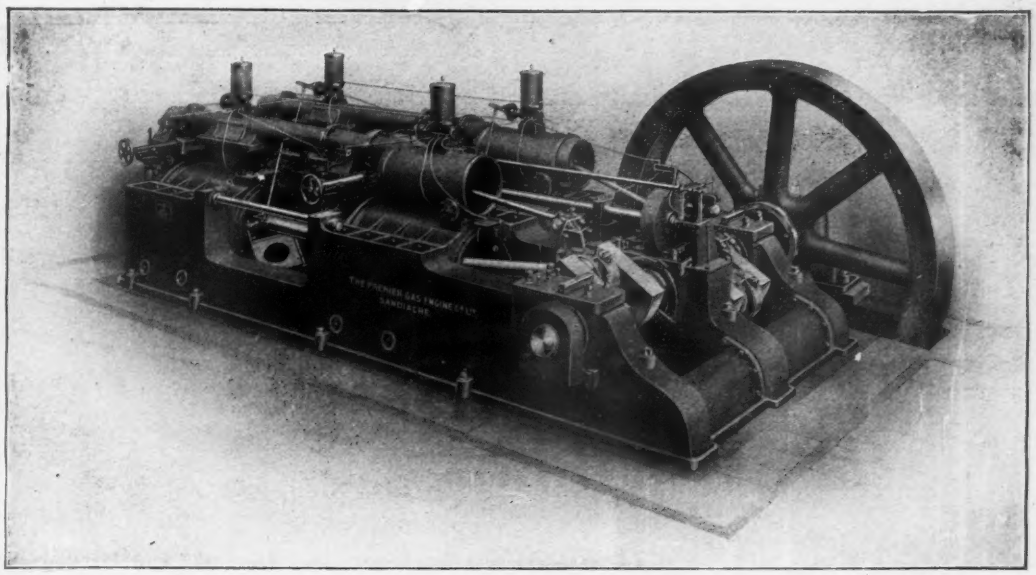

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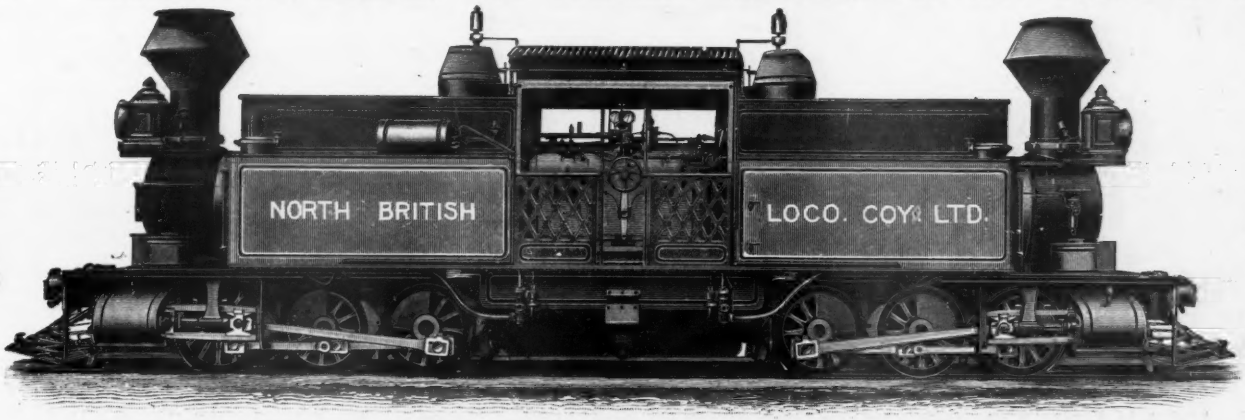


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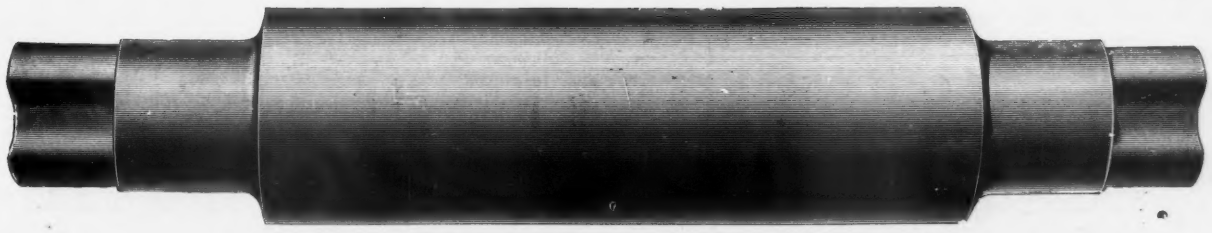

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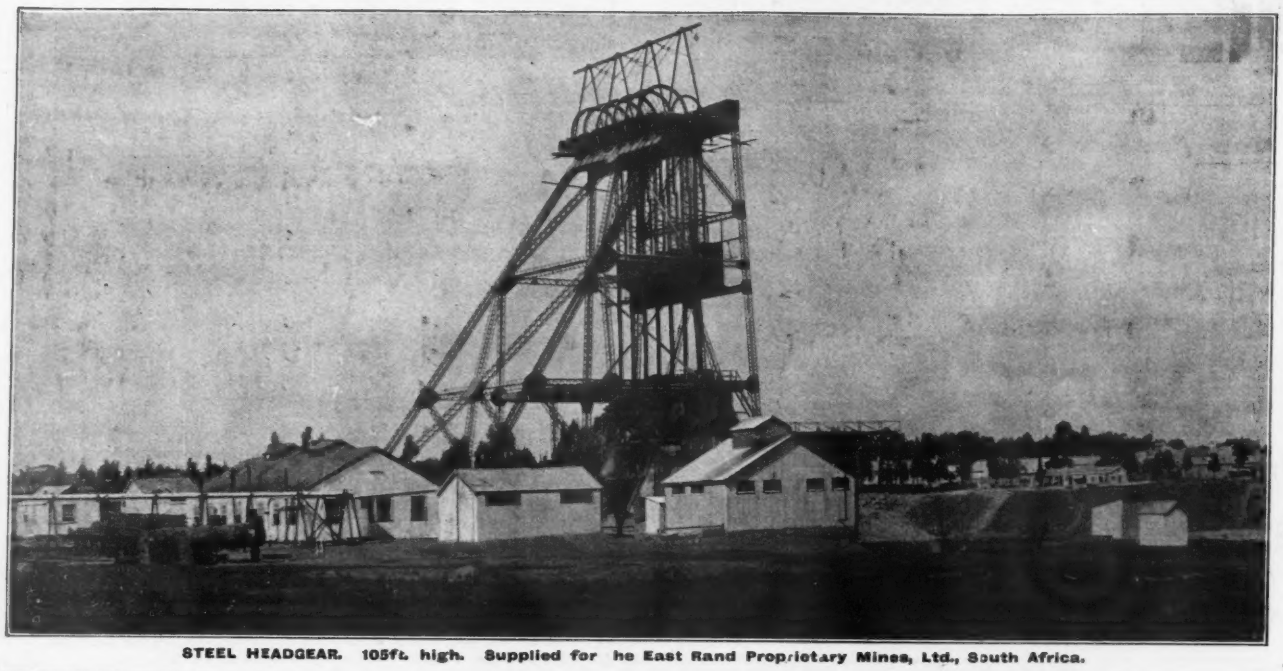

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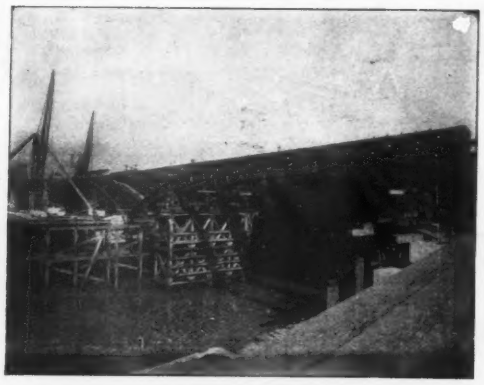

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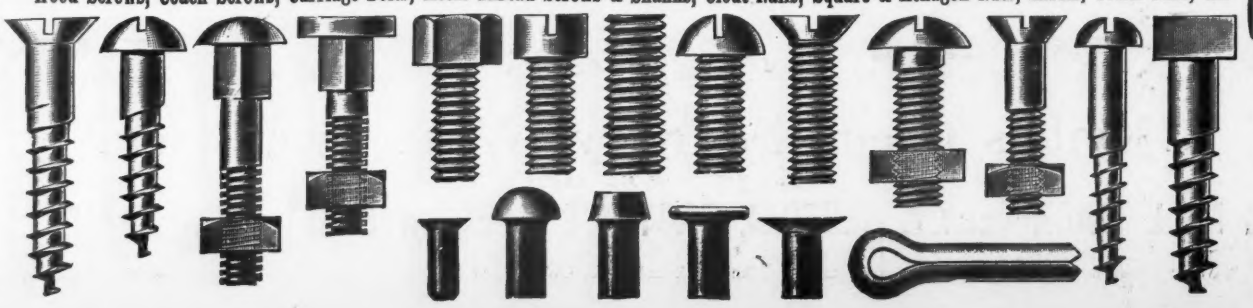

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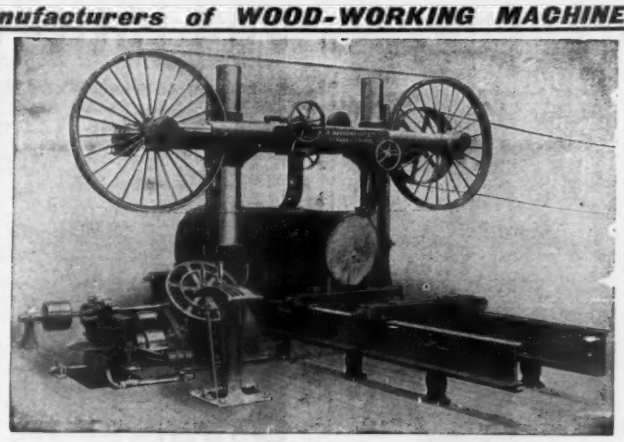

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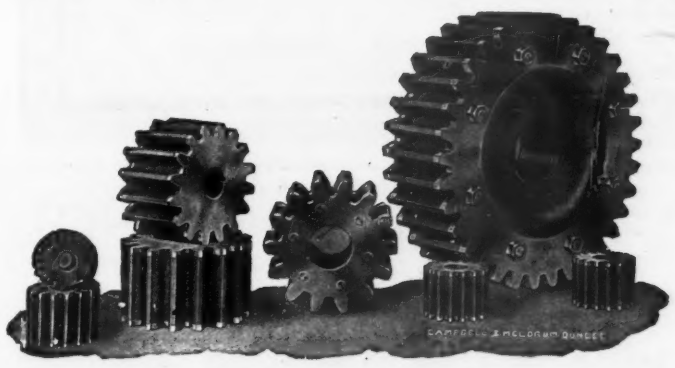

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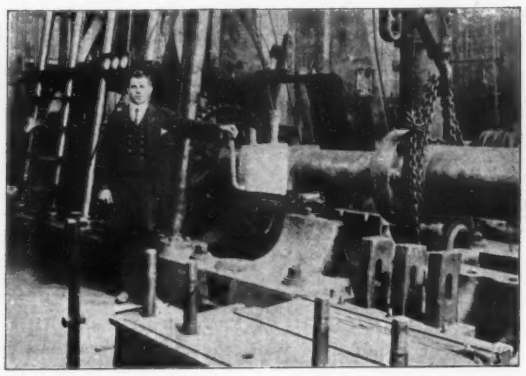

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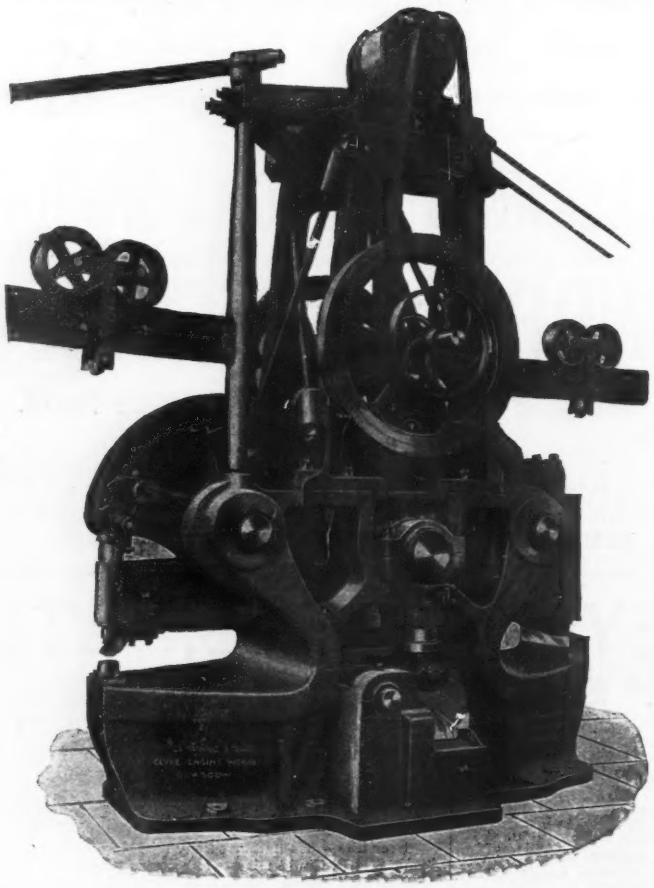

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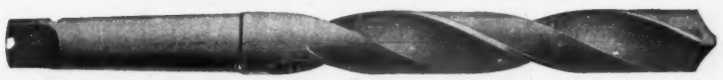

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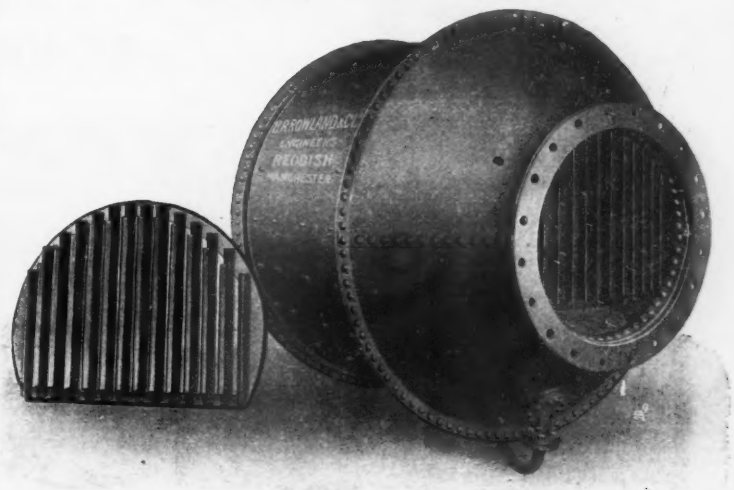


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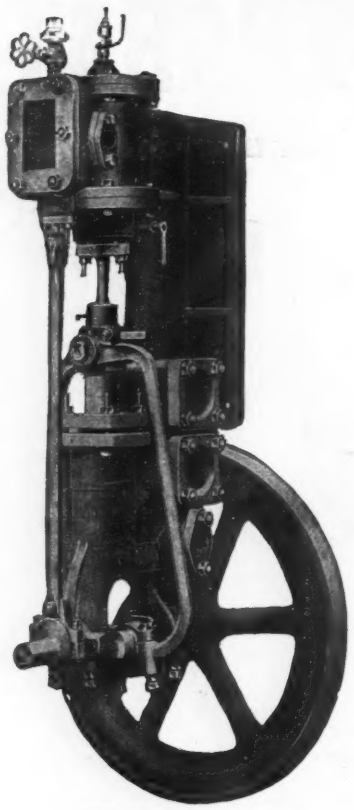

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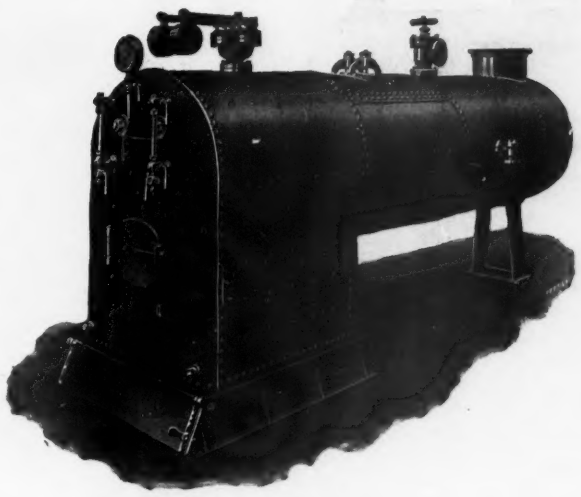

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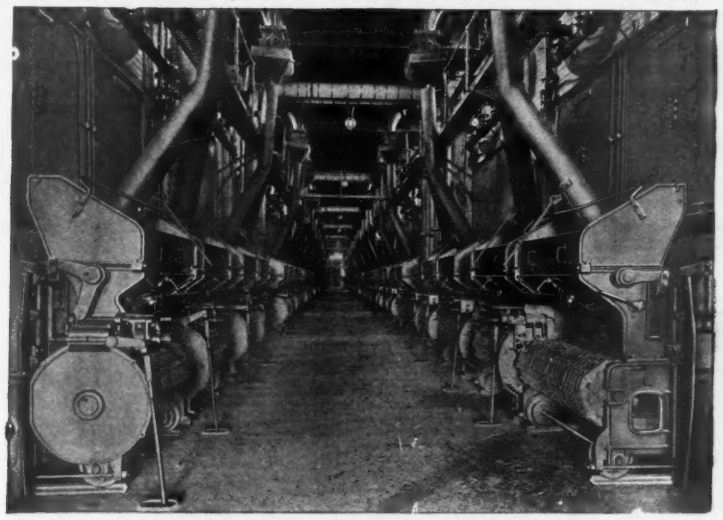

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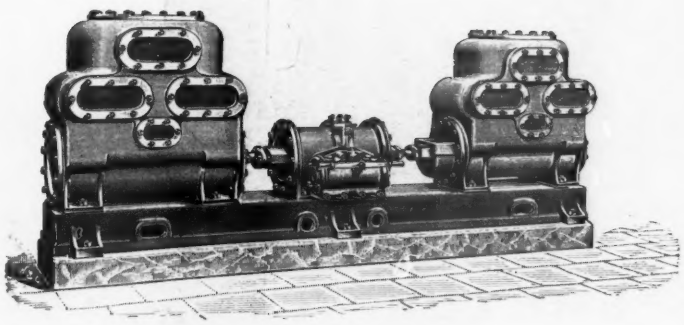

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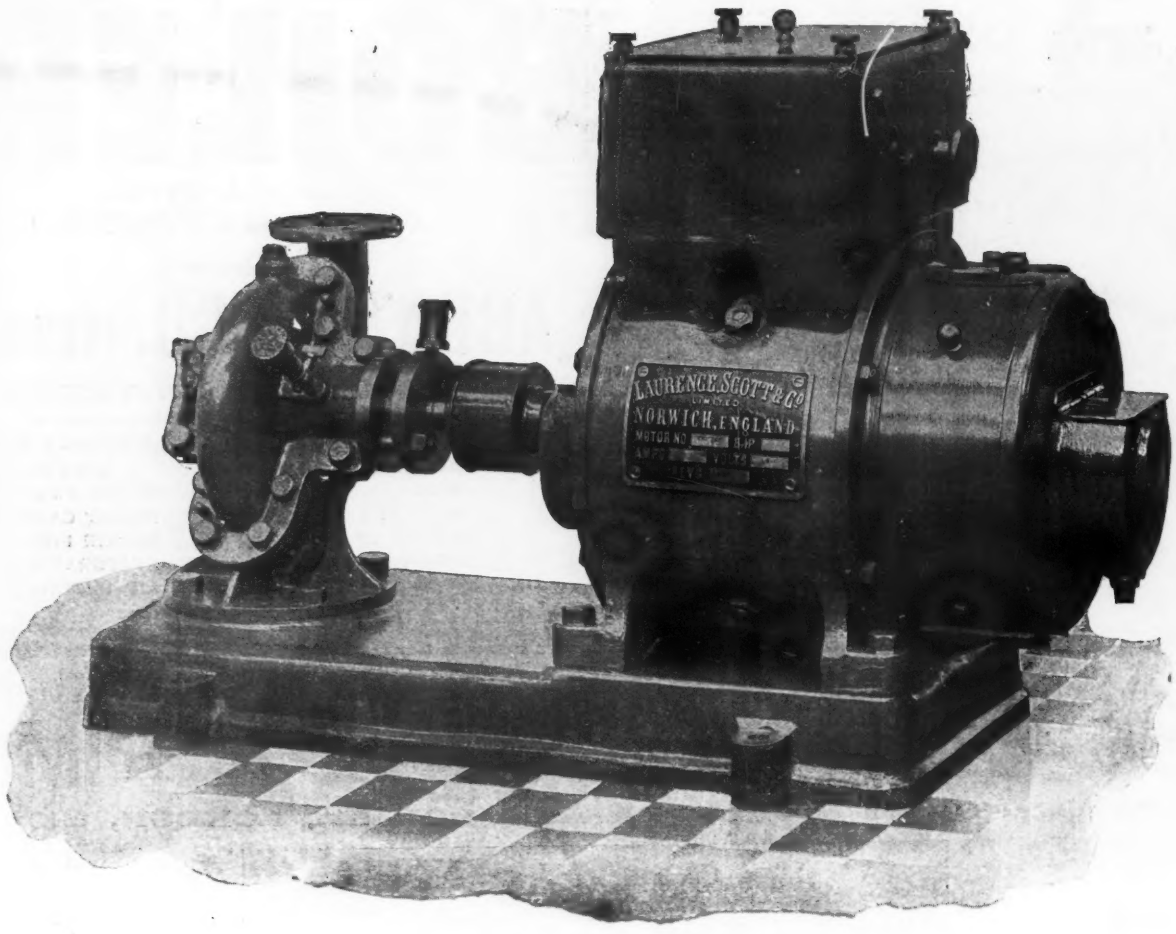


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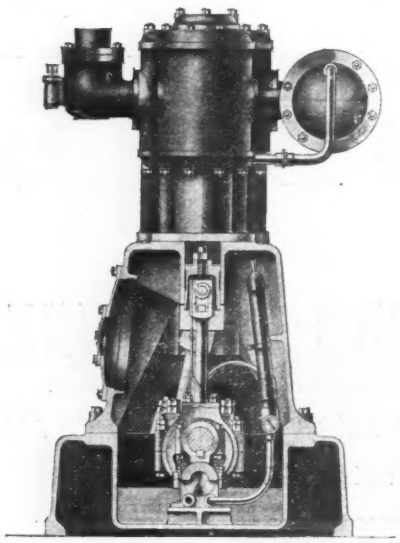

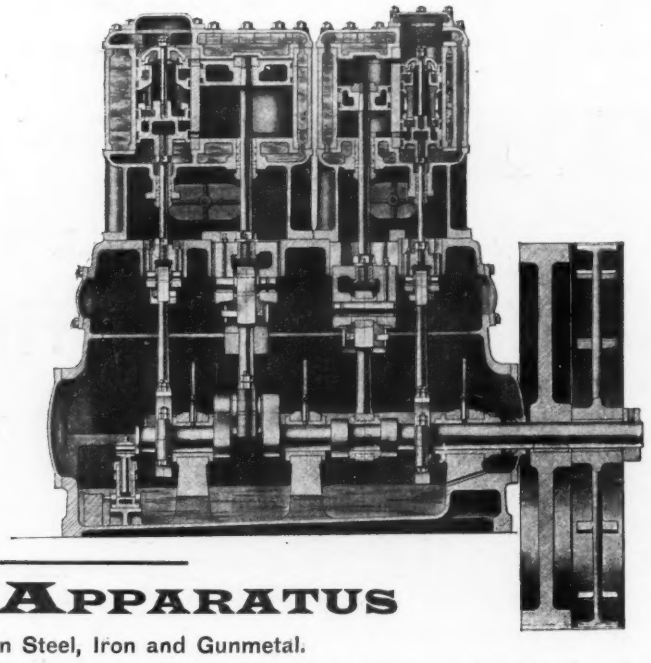

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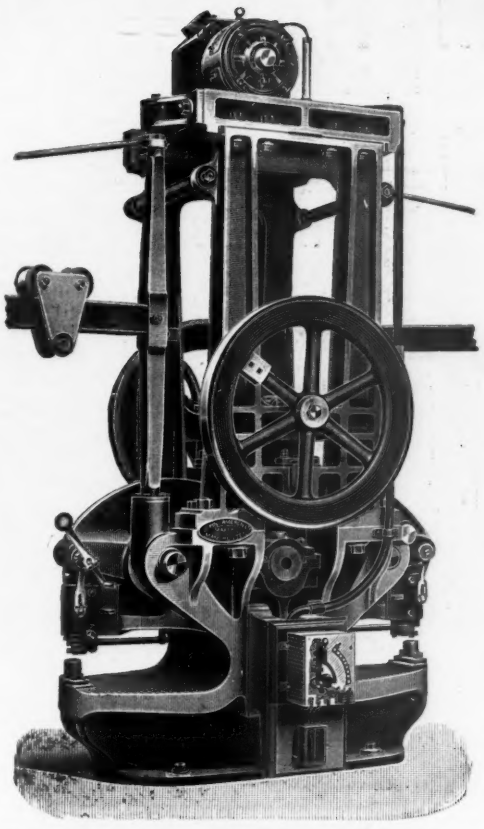

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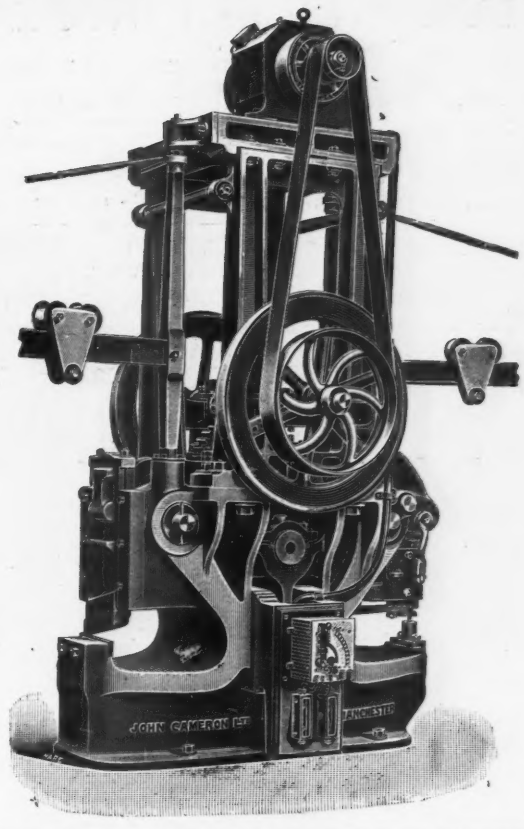


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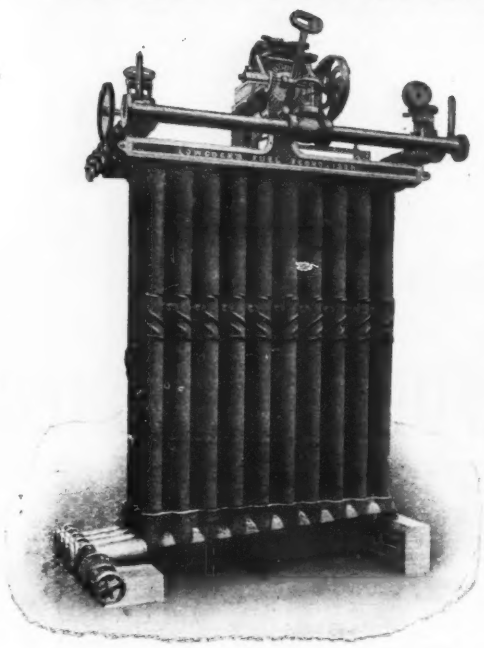

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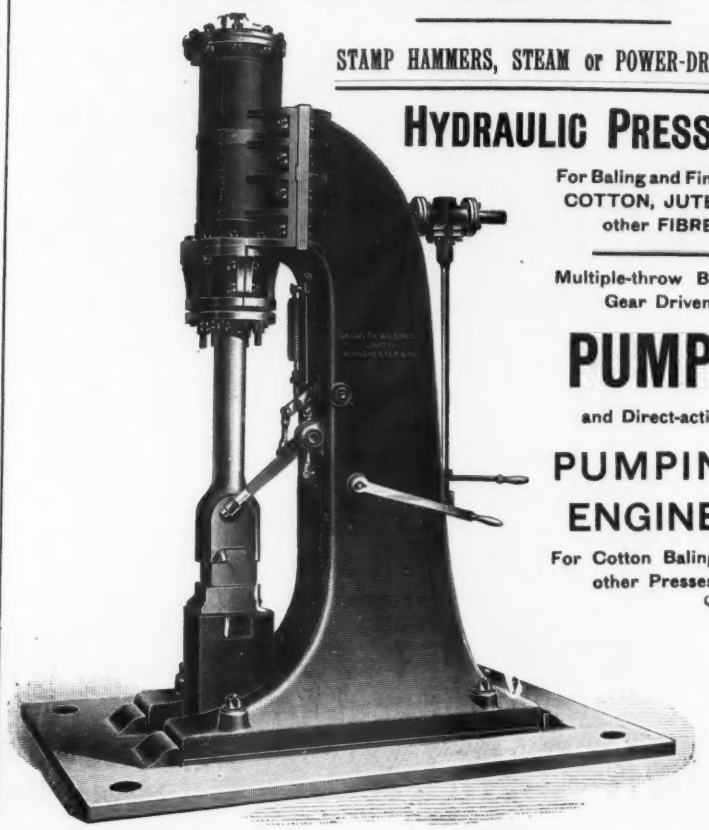

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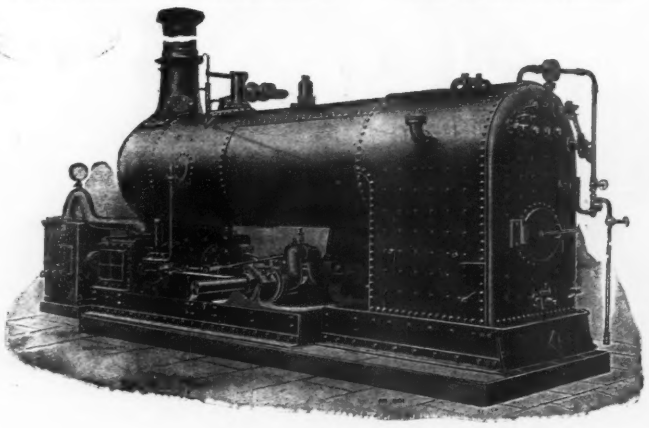

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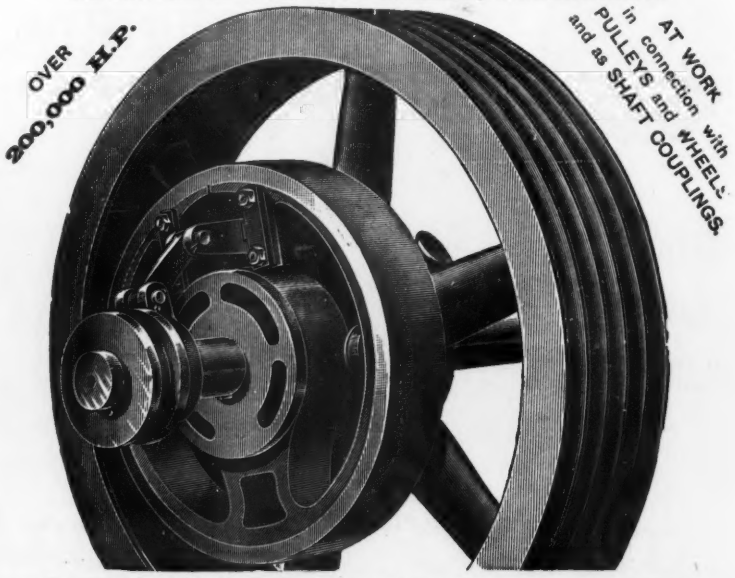


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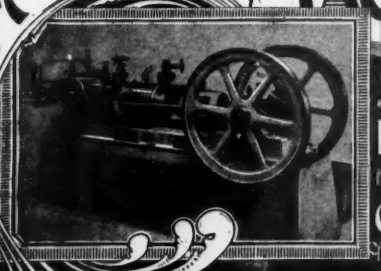

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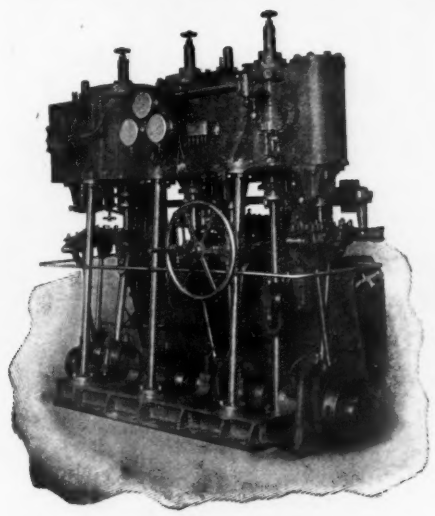

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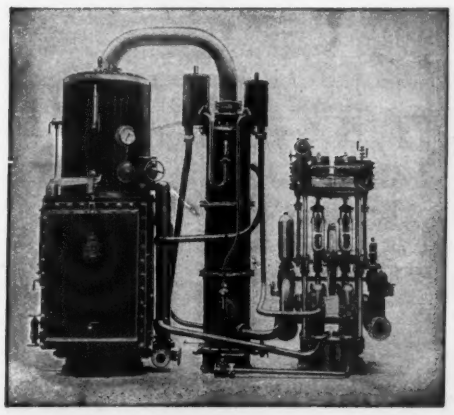

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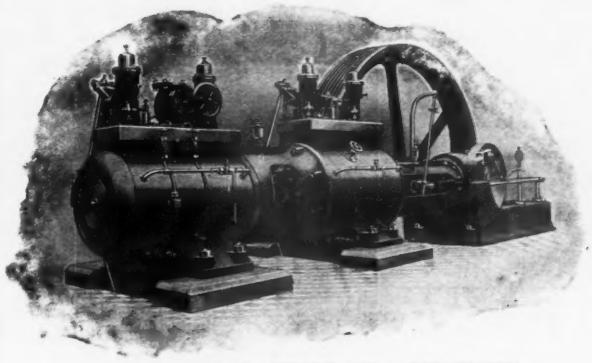

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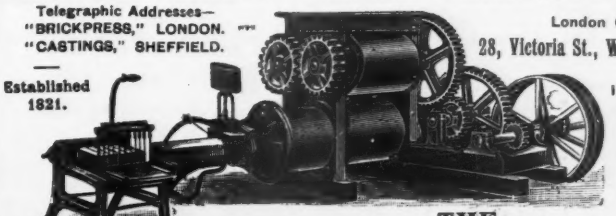

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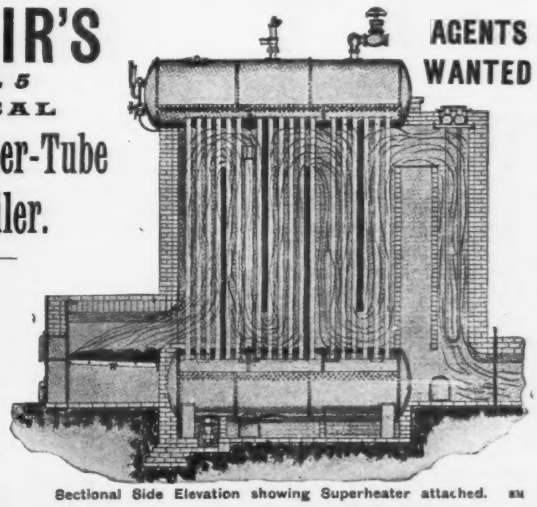

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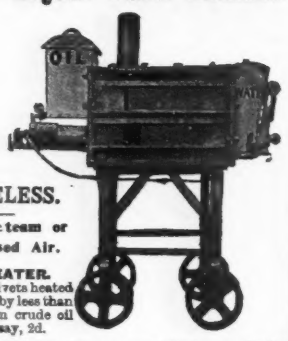


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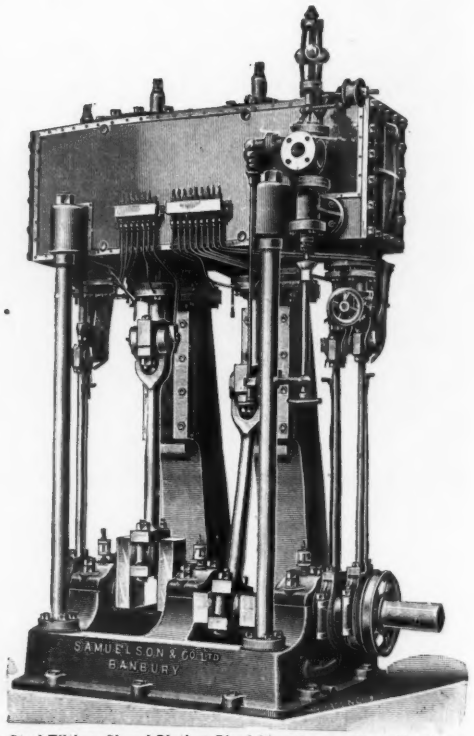


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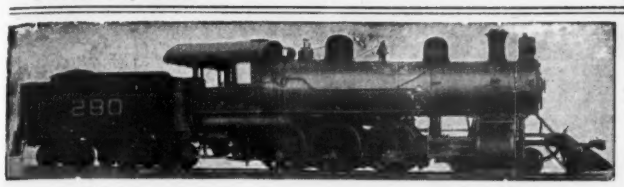

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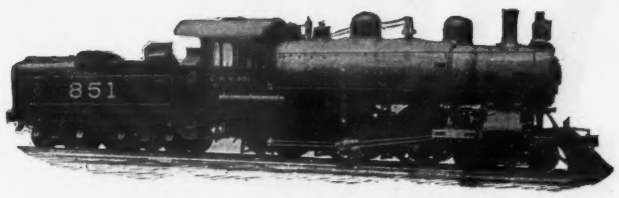

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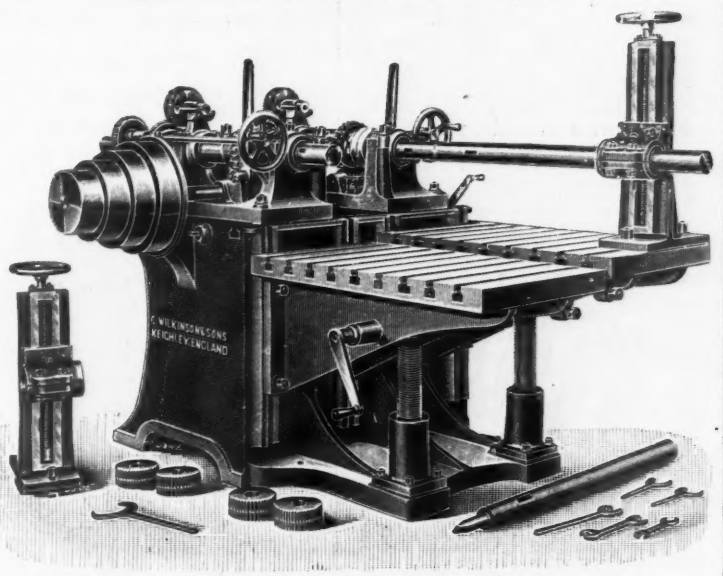


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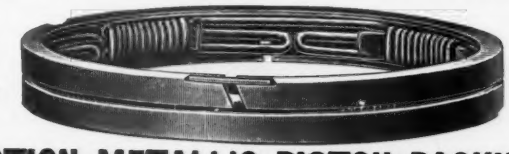

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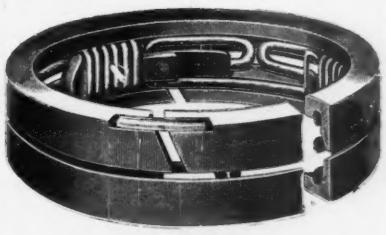

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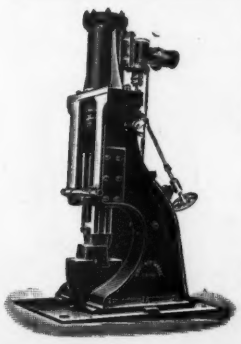

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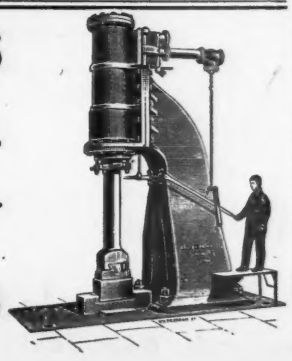

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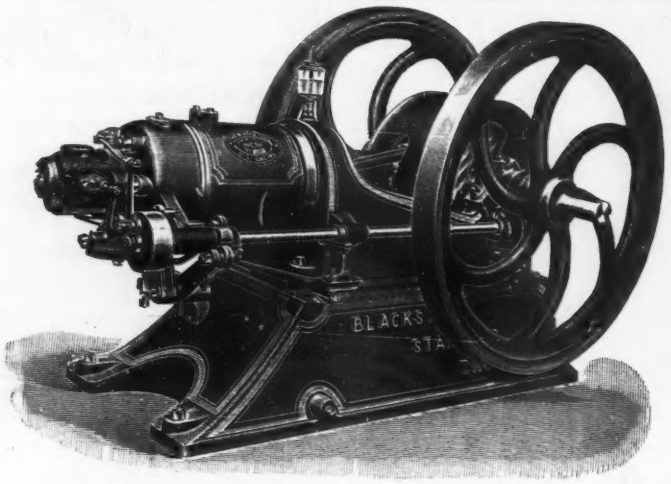

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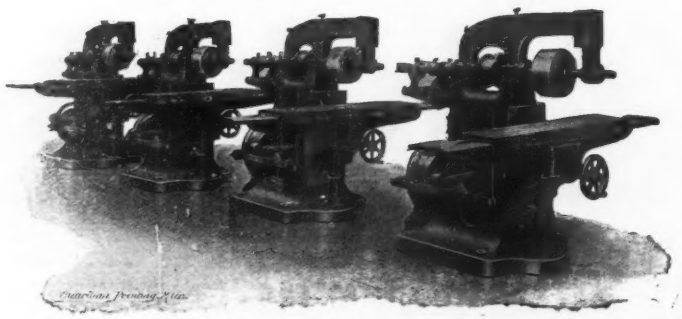

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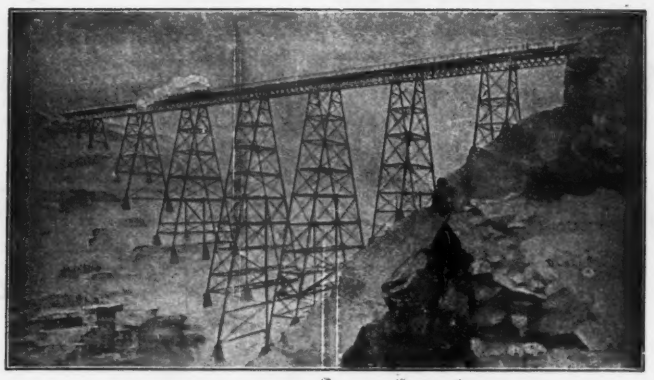

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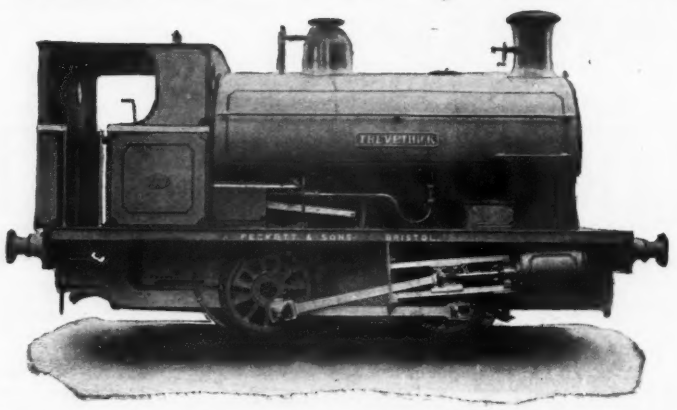

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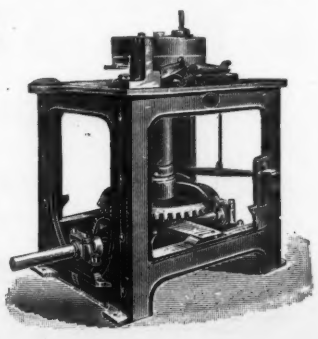

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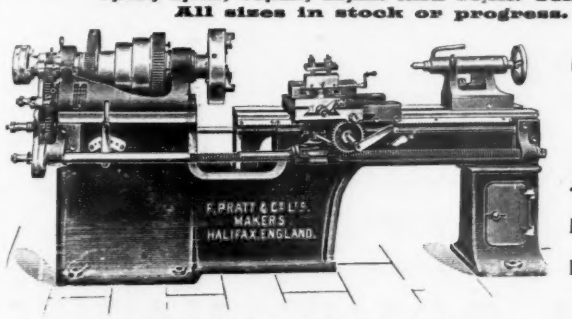


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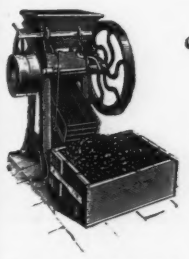

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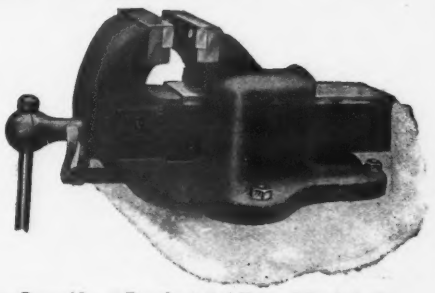

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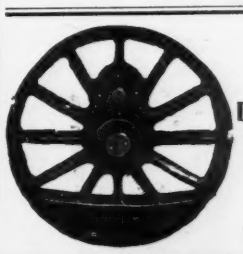

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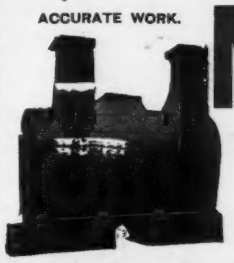

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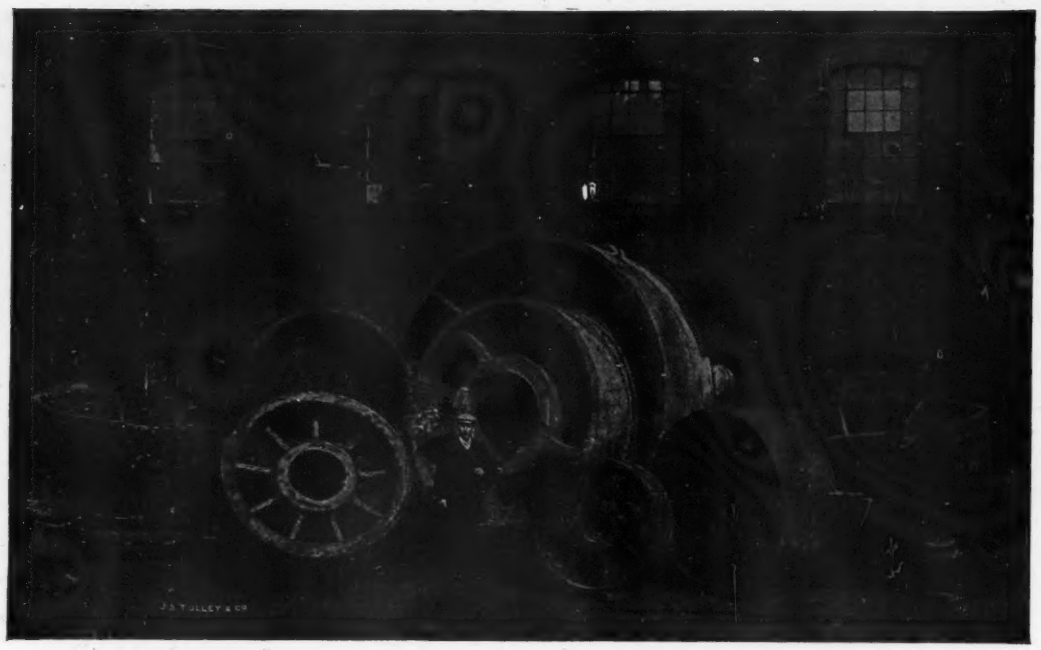

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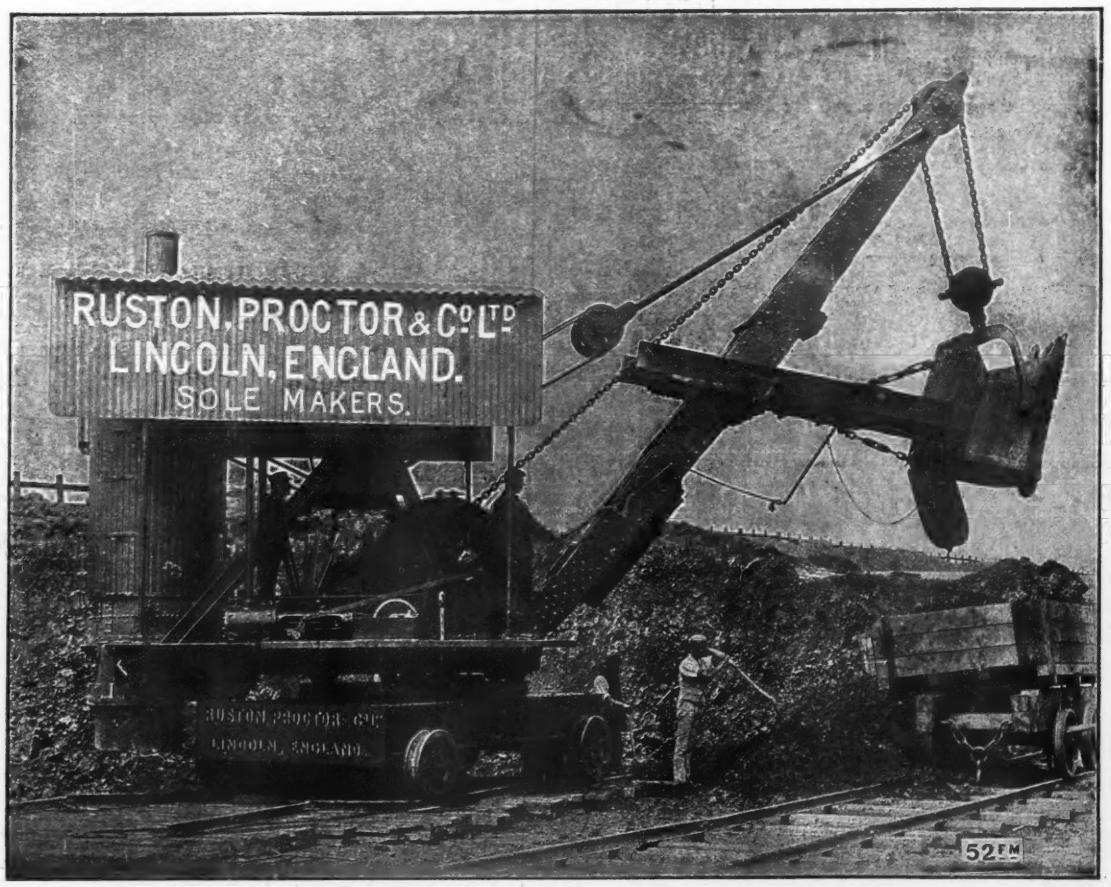


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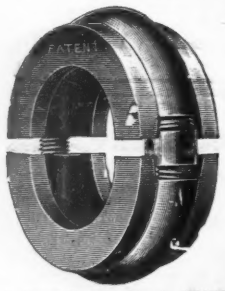

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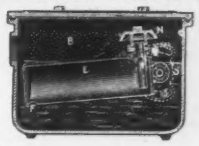

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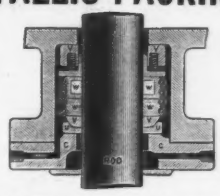

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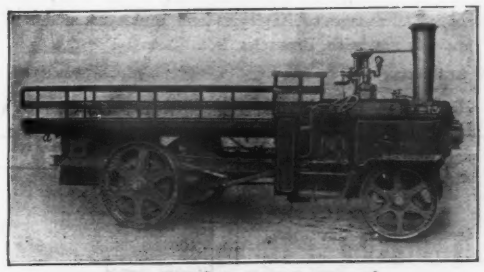

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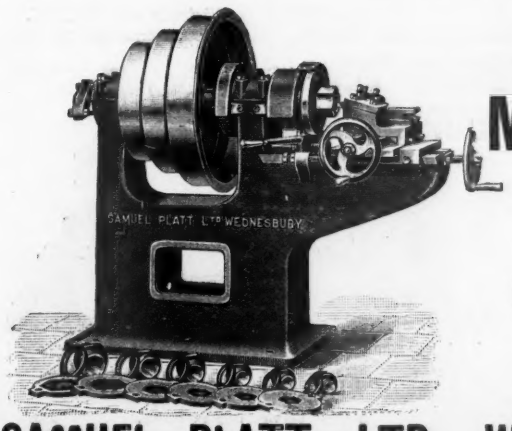


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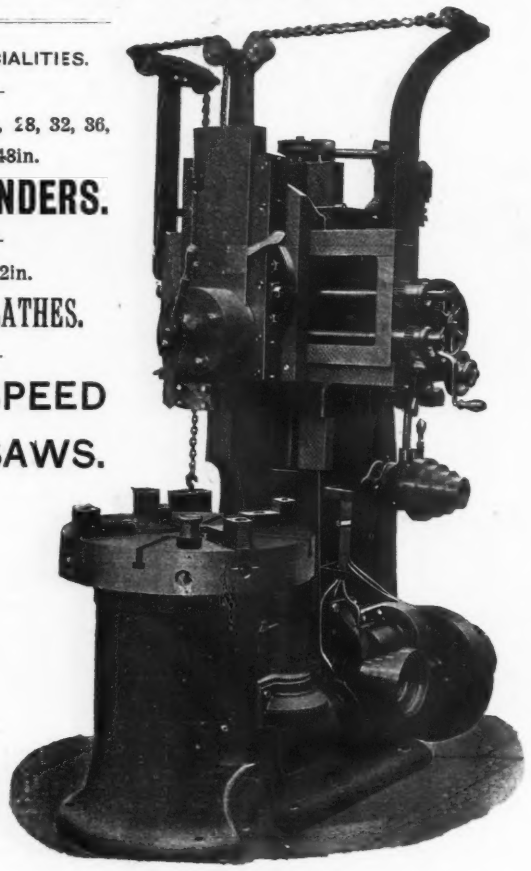

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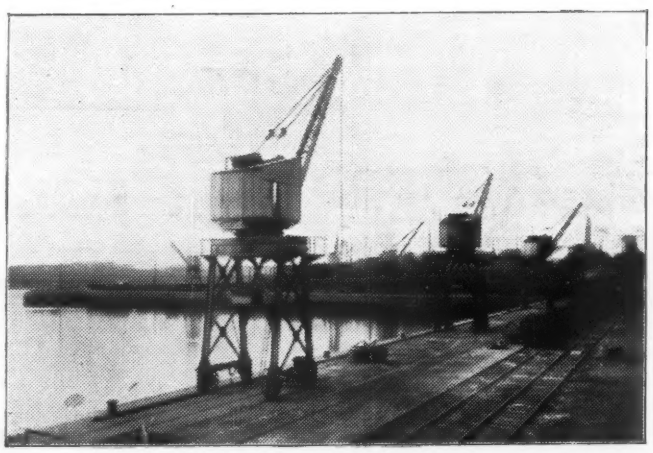

Fig. 981.—Electric Cranes, with Stothert & Pitt patented "Free Barrel" and Fielding Compensating Gear. X1493

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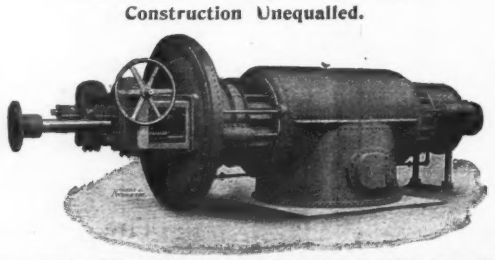

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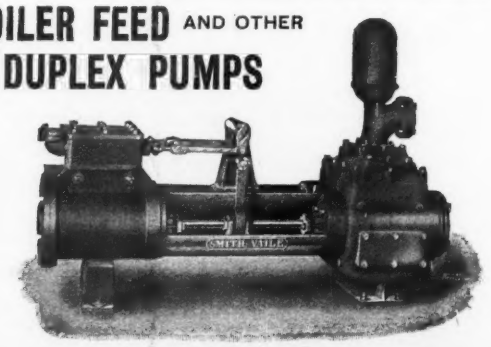

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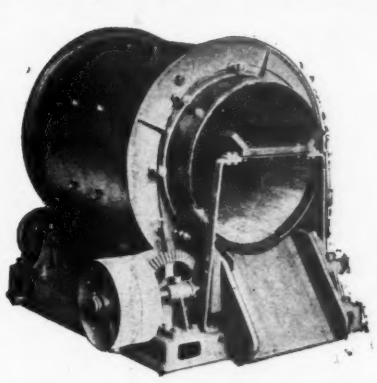
# MAGNETIC SEPARATOR.

*For Separating Iron and Steel from any other Material.*

THE MOST PERFECT MACHINE ON THE MARKET.



AS SUPPLIED TO THE ADMIRALTY.

**PRICES ON APPLICATION.**

Sole Makers:—

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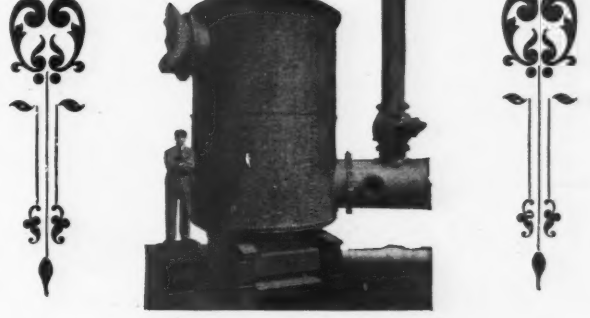
SHEFFIELD, ENGLAND.

(Spl) NI

THE

# 'BAKER' OIL SEPARATOR

FOR EXHAUST STEAM.



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At Present Working Satisfactorily - -

**IN THE MOST IMPORTANT ELECTRIC STATIONS & WORKS**

Throughout the United Kingdom and on the Continent.

WRITE FOR ILLUSTRATED CATALOGUE.

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# CRANES ALL TYPES

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T468

AERIAL CABLEWAYS & ROPEWAYS.

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Also BILLETS of dead soft quality, SLABS, BRIDGE PLATES, ANGLES, BULBS, CHANNELS, ROUNDS, SQUARES, TEES, ZEDS, &c.

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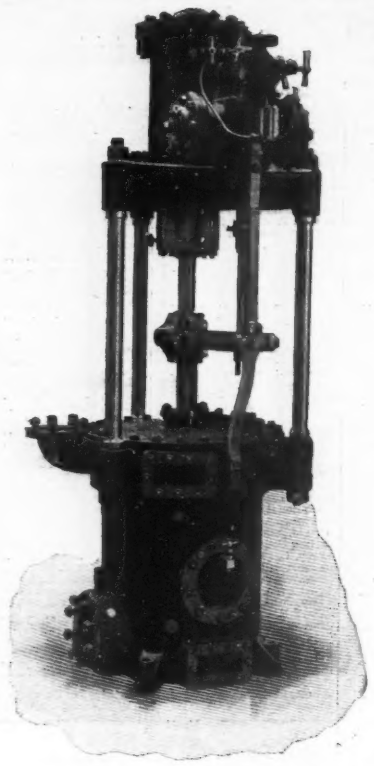

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Direct-Acting - - Positive Stroke.
Economical - - - Efficient.
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for Marine and Stationary
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Spl. 1870

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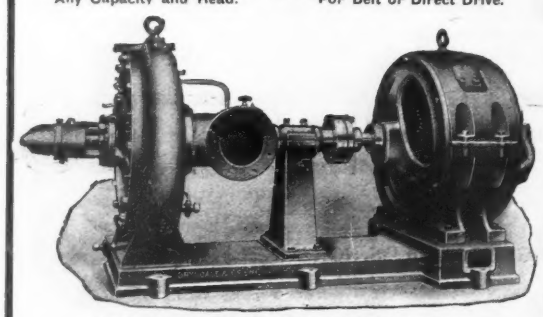

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Morton, F., and Co., Ld
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Klinger, R., and Co
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Burnham, Williams and Co
Davies and Metcalfe, Ld
Hawthorn, Leslie and Co., Ld
Henschel and Sohn
Hudswell, Clarke and Co
Hunslet Engine Co., Ld
Kerr, Stuart and Co., Ld
Locomotive and Machine Co. of Montreal
Lowca Engineering Co., Ld
North British Locomotive Co., Ld
Peckett and Sons
Stephenson, R., and Co., Ld
Vulcan Locomotive Works

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